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### AUTOMOTIVE and Uviation INDUSTRIES

APRIL 15, 1944



It's a day of Development, too!



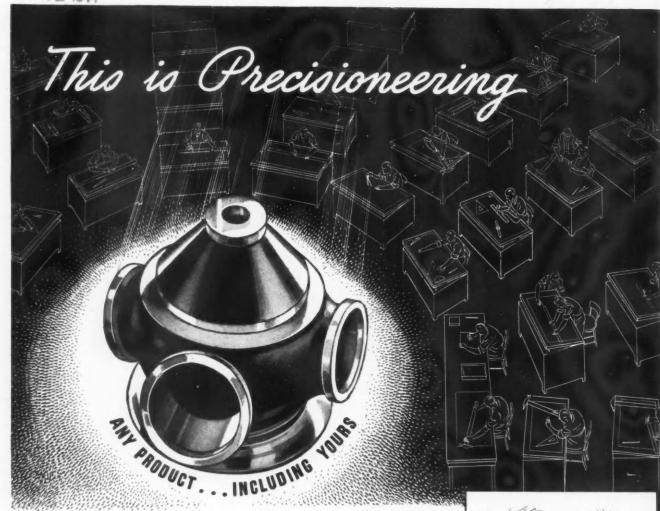
\* A Sikorsky XR-4 hovering motionless over East Hartford, Connecticut. This first helicopter to be delivered to the Army Air Forces is equipped with six Timken Bearings in the Main Rotor Blade, two in the Tail Rotor Gear Box, and six in the wheels. To meet the need of aircraft engineers for an anti-friction bearing — lighter in weight — of compact design — with maximum radial and thrust load carrying capacity — Timken engineers have developed a new series of tapered roller bearings.

Already, these bearings have contributed to the fine performance of Sikorsky helicopters... while giving them all the other advantages of Timken Bearing design for aircraft applications: assured smoothness of operation... ease of handling... power conservation and endurance... economical maintenance.

Consult us on your requirements. We will be glad to make recommendations.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN
TAPERED ROLLER BEARINGS



### 125 Man-acres of Engineering Brains to help you cut precision machining costs

Heald Precisioneering is the procedure of "thinking it out". It's "thinking-out" precision boring, facing, turning, grinding problems... to cut costs to the bone, speed production, UP precision or whatever the requirements may be. Then—to supply the machine, and the tooling to do the job.

Heald *Precisioneers* are a unique organization of over 250 precision engineers. They devote their entire time to precision machining problems. They draw on

a veritable encyclopedia of production "know-how".

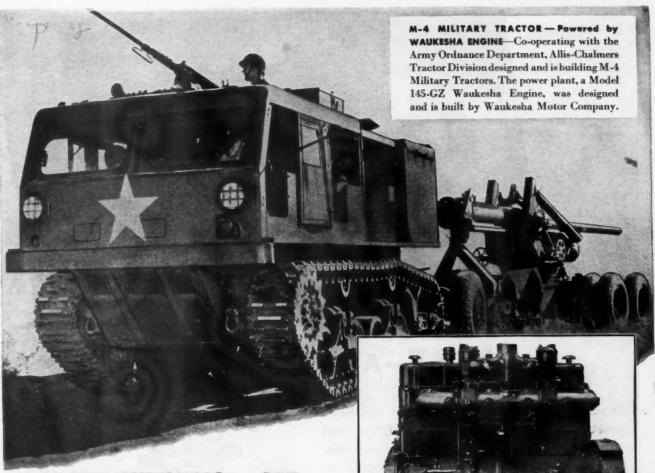
Let Heald Precisioneers help you plan your post-war production. They can make available to you proved ideas especially developed for war production . . . the last word in precision machine tools and precision machining technique. We cordially invite you to visit Worcester and see for yourself. Or, if you prefer, ask our nearest representative to call.

THE HEALD MACHINE COMPANY WORCESTER 6, MASSACHUSETTS

#### Precision Turning Electric Motor Rotors

The rotor must be held to 2.500"
—2.501" O.D. concentric with the shaft within .001" total indicator reading, and parallel to .004" in 12". Grinding proved exceedingly troublesome—wheels would quickly load with soft aluminum—production only 70 an hour. When precision turned two at a time on the Heald No. 49 Bore-matic, accuracy and finish was fully satisfactory. Production? 200 an hour.

### HEALD Precision .. first, last, always



NOT MEN AND MULES ... BUT

### WAUKESHA HORSEPOWER

### HAULS HEAVY GUNS INTO ACTION

The motive power of men and mules that once hauled artillery isn't fast enough for this war. To get there first with superior fire power, our Field, Coast and Anti-aircraft Artillery must move faster...and faster!

Neither shell holes nor ditches, muck, mud nor mountains stop the new track-laying M-4 Military Tractors from moving the heaviest guns into position. Powered with Model 145-GZ Waukesha Engines, they have all the pulling power of a track-type tractor plus the smooth eager speed of a truck.

This is a wartime Waukesha Engine...a special development for combat service in heavy ordnance equipment...a super power plant built by Waukesha to out-power and out-perform any similar engine of the same size ever produced!

#### MODEL 145-GZ WAUKESHA ENGINE

Six cylinders, 53% in. bore x 6 in. stroke, 817 cu. in. displ. Burns gasoline... is designed to use modern aviation fuels... develops high output. And it's really rugged! Crankcase and cylinder block cast as a single unit. Crankshaft is drop-forged steel, heat treated. Wet sleeve cylinders easy to remove and replace. Positive pressure oiling. Thermostatic by-pass system guards against over-cooling, assures quick warm-up when starting.

Right now all Waukesha production is for war work. After the war is won, peacetime Waukesha Engines will be ready for all your special requirements. Consult Waukesha engineers now about your future engine needs.

WAUKESHA MOTOR COMPANY, WAUKESHA, WIS.
NEW YORK • TULSA • LOS ANGELES



WAUKESHA ENGINES

April 15, 1944

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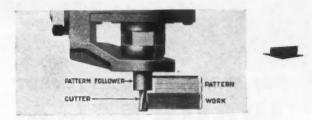


### FIRST-And Still Leading

It was in 1936 that an Onsrud router first made practical the technique of high speed, fast feed cutting of sheet aluminum aircraft alloys. Machines like this Onsrud Radial Arm Router are still providing the most efficient, speediest production of the many nonferrous parts they're capable of handling.

This particular machine has a 114" reach covering all points on two 4' x 12' work tables set at opposite sides of its base. Routing and drilling of stacked sheets may be done in one setup. A total thickness of 34" of stacked sheets can be cut at one time with savings in time and material that are readily apparent.

To find out what Onsrud equipment and engineering service can do for you, send for bulletin describing this machine today. If you prefer, just write us about your nonferrous cutting problems—our engineers can probably help with cost-free suggestions or recommendations.



A pattern is fixed to the stacked flat or corrugated sheets. Pattern follower travels along pattern's side allowing cutter to reproduce the desired shape in the work. Both inside and outside cuts are made accurately and speedily and the 15,000 RPM spindle speed of the machine assures that finished work has clean, finish-smooth edges.



Onsrud radial arm machines are also available for fast accurate flat sheet drilling as well as routing.



ONSRUD MACHINE WORKS, INC. 3925 Palmer Street • Chicago 47, Illinois Sales Offices in all Principal Cities

MACHINE TOOLS AND METHODS FOR TOMORROW'S PRODUCTION

Vol. 90

April 15, 1944

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April 15, 1944

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These are filters-not projectiles. But projectiles might never reach their destination if these filters did not do their jobs first. They are a small but vital contribution to the huge war machine we have built to control the air . . . the field . . . and the seas.

The four plants of The Weatherhead Company have been making filters by the hundreds of thousands as one of its many contributions to the nation's war effort. Peace will find us prepared to resume making filters-and scores of other mechanical parts-for the machines that will reconstruct the world!

FREE: Write on company letterhead for "Seeds Of Industry" - a history of The Weatherhead Company, its many facilities and diversified products.



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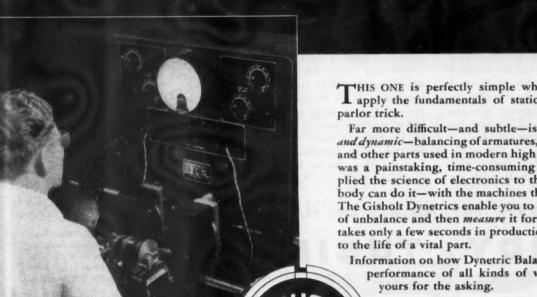
### Weatherhead

CLEVELAND, OHIO Manufacturers of vital parts for the an

aviation, refrigeration and other key industries.

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# BALANCING is full of Tricks



THIS ONE is perfectly simple when you know how to apply the fundamentals of static balancing. It's just a

Far more difficult-and subtle-is the two plane-static and dynamic-balancing of armatures, crankshafts, impellers, and other parts used in modern high speed machinery. This was a painstaking, time-consuming task until Gisholt applied the science of electronics to the problem. Now, anybody can do it—with the machines that know all the tricks. The Gisholt Dynetrics enable you to quickly locate the point of unbalance and then measure it for accurate correction. It takes only a few seconds in production. But it can add years

Information on how Dynetric Balancing is improving the performance of all kinds of vital war equipment is

> GISHOLT MACHINE COMPANY 1205 East Washington Ave. . Madison, Wisconsin

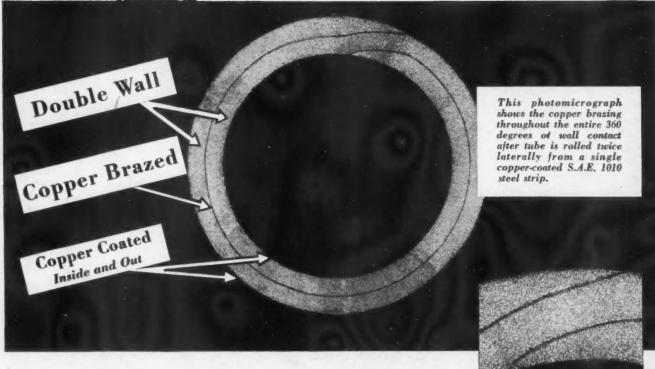
> Look Ahead.. Keep Ahead.. With Gisholt

URRET LATHES • AUTOMATIC LATHES • BALANCING MACHINES • SPECIAL MACHINES



# Take a Good Look at BUNDYWELD

The Solid Double Wall Steel Tube



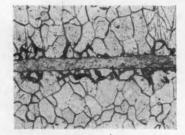
### See What the Microscope Reveals

When Bundyweld tubing is under the microscope, as it is here, you can see the uniform, solidly bonded structure of this double wall steel tube...how the two steel walls are copper brazed throughout the entire 360 degrees of wall contact by Bundy's special brazing process.

From the brazing furnace and long cooling chamber, both with re-

ducing atmospheres, Bundyweld emerges with a clean, mirror-like finish and high ductile properties which make this tubing easy to fabricate. It is furnished hard or annealed, in a wide range of standard diameters and gauges up to 5%" O. D. Special sizes cold drawn as desired. Also furnished in Monel. For details — write Bundy Tubing Company, Detroit 13, Michigan.

This photomicrograph of Bundyweld tubing shows a still greater enlargement of the joint. Note how the beveled steel strip makes a perfectly-shaped joint without any visible seam.



Still further enlarged, this photomicrograph of the union between the two walls shows how the copper diffuses between the steel grains to form a perfect bond of the two metals.

Food is Vital.
Plant a Victory Garden This Year.

"FAMOUS LIFE LINES" FOR WAR AND PEACE



Pacific Metals Company, Ltd. 3100 19th Street San Francisco, California

Standard Tube Sales Corp.

1 Admiral Avenue
Maspeth, New York City, N. Y.

Lapham-Hickey Company 3333 W. 47th Place Chicago, Illinois Rutan & Company 112 South 16th Street Philadelphia, Pensylvania Eagle Metals Company 3628 East Marginal Way Seattle, Washington



### comin' in on a wing and a prayer—AND HYATTS!

OUT OF THE SMOKE OF BATTLE, out of the range of the enemy...a bomber limps home with a wing, its tail, belly, and two of its four engines shot full of holes.

It has dumped another load of bombs over the Rhineland today... punched some more holes in the Axis industrial machine. But, like the men who man them, these planes must be built to "take it" as well as "dish it out."

This...in a word...takes "guts." After all, it is what's inside the shell that really makes a plane tick when the chips are down.

Inside are hundreds of precision parts...parts that are knit into unfailing strength. Prominent among these parts are the smooth rolling Hyatt bearings into which we build great capacity while holding them true to required precision tolerances.

At Hyatt, you see, we developed and use the centerless I.D. grinding process exclusively, and this always assures the uniform wall thickness of our bearing races...therefore, perfect concentricity, perfect balance.

A perfectly circled raceway prevents eccentricity...the main cause of vibration, one of the things that could spell disaster for a plane and its engines.

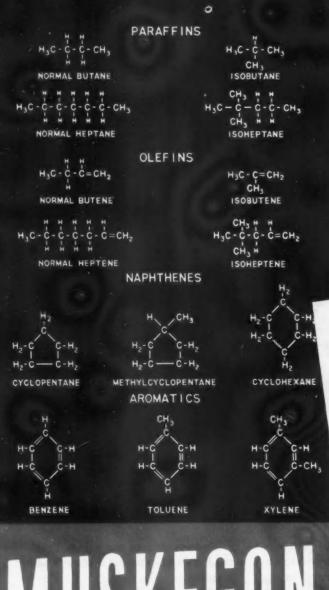
By minimizing vibration, increased horsepower is helped made possible. And this increased power is mighty comforting to flyers "comin' in on a wing and a prayer."

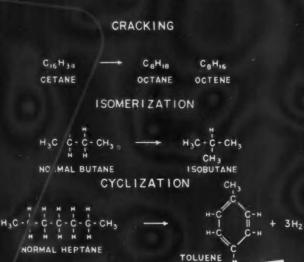
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# HYATT BEARINGS

HARRISON, N. J.

### WHAT WILL BE THE OCTANE RATING OF AUTOMOBILE GASOLINE?





POLYMERIZATIO

Many factors, some technical and some economic, will combine to furnish the ultimate answer to this question. The greater power potential of 100 octane gasoline will have to be balanced not only against its higher cost but also against the status of the nation's oil supply.

Some significant developments have already made it possible to produce fuel of much greater power, and synthetic catalysts may greatly reduce the cost of manufacture. Constant efforts of automotive engineers to produce better automobiles plus the possibility of higher octane gasoline promise increased operating economy and mechanical efficiency.

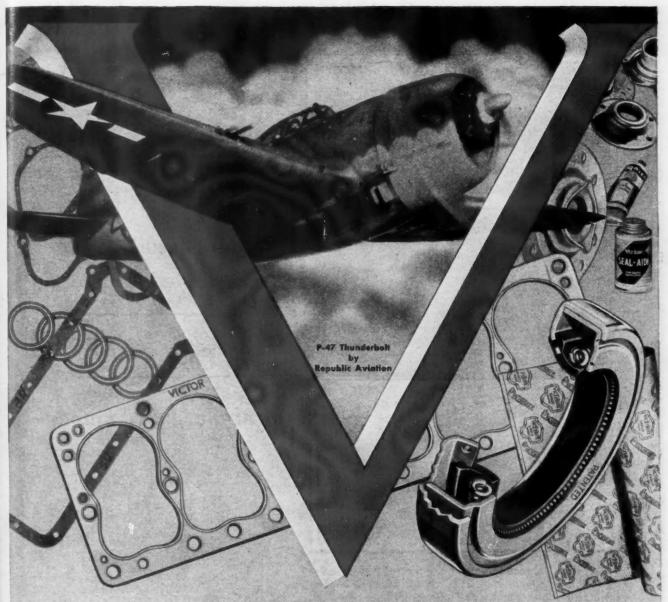
Whatever developments in engine fuel the future may bring, performance and economy, as always, will depend in a large degree upon the efficiency of the piston rings. Muskegon, with years of experience in designing and producing piston ring castings and finished piston rings for all types of automotive, aviation and industrial engines, is alert to future developments through gines, is dierr to future development.

Muskegon's engineers and metallurgists are ready now to confer with all forward-looking designers who are planning the engine of the future.

Buy an EXTRA War Bond

MUSKEGON PISTON

MUSKEGON, MICHIGAN Plants at Muskegon and Sparta



### FASTER AND HIGHER

Victor gaskets and hydraulic packings do their jobs in the extremely low temperatures and other severe operating conditions encountered when the P-47 fights at over 400 M.P.H. and at altitudes of more than 40,000 feet. Victor Manufacturing and Gasket Co., P. O. Box 1333, Chicago, Ill., U. S. A.

# WICTOR GASKETS · OIL SEALS



Yesterday—Gun ordnance manufacture was not yet an industrial art in Civil War times. Crude, cast gun barrels, lack of recoil mechanisms, and loose tolerance machining limitations made artillery fire a mechanically haphazard accomplishment.

World War I introduced the dependably accurate precision of the French 75 mm. gun. It could take the roughest kind of field handling. It could always register on a target with only a few rounds, and thereafter remain registered under a high rate of fire.

PHOTO COURTESY "ARMY ORONANCE"



Today—Tactical requirements of the present War have demanded new types of guns. They must fire heavier caliber shells faster, farther and for a longer time. They must outrange and out-fight all enemy guns. Increased muzzle velocities, better control of the shell trajectory, reduction of fouling of the lands and grooves of the rifling are all major requirements in modern high power, fast firing guns. These accomplishments are made possible by the hone abrading method of metal processing.



Microhoning
Helped develop the
DEPENDABLE
PRECISION

of Modern Ordnance

Tomorrow-When at last peace may come again, the guns of industry must be accurately registered and rapidly

be accurately registered and rapidly demolish the many targets of pert-up demands for industrial goods. Time—and methods—will be of the essence. Microhoning will be ready with new developments offering substantial mechanical advancement and time saving over pre-war methods.

Microhoning is a process of finish machining which generates bore accuracy for roundness and straightness within .0002" to .0003"—which removes up to 65 cubic inches of stock per hour, has been developed into many ramifications, now being used for war machines. Tomorrow they will be available to speed peacetime production.

icromatic Hone corporation - Detroit 4, Michigan
MAKERS OF HONING MACHINE TOOLS



# Shooting the "BIG DUCKS" MILES AWAY

Shooting enemy planes at a distance of several miles is like shooting big ducks on a grand scale. The gunner must "lead" the target to allow for its movement while the shell is getting there.

Hence, the antiaircraft gun is never sighted at what it is trying to kill—but at some point in advance of the target.

The eye and experience of the most expert duck hunter would be of little use in shooting these "big ducks." The pointing of the gun is a complicated mathematical problem, solved by an elaborate plotting machine. The gun must follow orders of this plotting device with utmost exactness.

Without precision of the very highest order in every critical part, the gun couldn't hit the "big ducks." Antiaircraft fire would be mildly annoying instead of having deadly accuracy.

Microhoning contributes largely to this re-

sult because it provides the modern production approach to precision in final stock removal—maximum precision control of surface character.

Without this production approach to precision, it would be impossible to build these "big duck" guns in the quantities needed,

#### Some Microhoned Bores in Antiaircraft and Other Ordnance

Rifle Barrel Lands • Rifle Barrel Grooves • Recuperator Cylinders • Regulator Cylinders • Variable Recoil Cylinders • Rifle Hoops • Tapered Gun Chambers...(Guns from 2½ feet to 75 feet long—.30 caliber to 16 inch in diameter).



MICROMATIC HONE CORPORATION

DETROIT 4, MICHIGAN

### It's what goes on inside that counts



"blow-by" must be avoided

"BLOW-BY" is a costly evil. This leakage from the combustion chambers past the piston rings eats the oil off the cylinder walls, destroys lubrication, and causes excessive wear as well as power loss.

PEDRICK precisioneered piston rings prevent "blowby" because they are Heat-Shaped. This exclusive PEDRICK process relaxes the stresses set up in the metal from machining operations and makes possible a ring shaped so accurately that it is absolutely lighttight in a cylinder. This shape is permanent, too, so PEDRICK rings assure the best possible seal against destructive "blow-by" for the life of the installation.

Heat-Shaping is just one of numerous features which account for the excellence of PEDRICK piston rings, for their high performance, and long life in all kinds of engines and compressors up to 36-in. diameter. Perhaps we can help you improve the units for which you are responsible. Why not write for the complete PEDRICK story now?

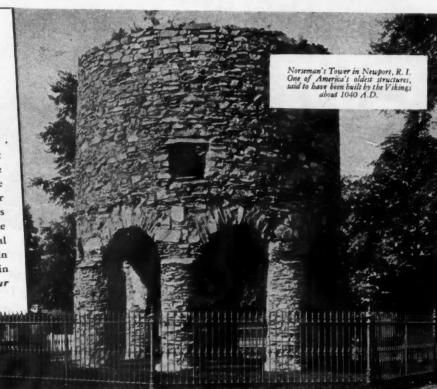
WILKENING MANUFACTURING CO., Philadelphia 42 and Scranton, Pa. *In Canada*: Wilkening Manufacturing Co. (Canada) Ltd., Toronto.

KEEP UP THE GOOD FIGHT-



# Stalwart against Time

THE REPUTATION of Tobe Capacitors for long life rests on a record of practically no "returns". Ratings are always conservative. Constant research ... manufacturing skill born of long, specialized experience...frequent, rigid inspections-these are the "secrets". of Tobe's ability to master difficult specifications, like those of the new American War Standards. The "DP" Molded Paper Condenser shown below is an example. It is made of high grade Kraft tissue paper and aluminum foil - mineral oil impregnated and molded in low-loss Bakelite. Leads are tin copper wire. Whatever your condenser problems, Tobe engineers will gladly work with you. Inquiries and requests for samples will receive prompt attention.



### LONG LIFE ASSURED



### SPECIFICATIONS "DP" MOLDED PAPER CONDENSERS

Flash test 3 times rated DC working voltage
SHUNT RESISTANCE At 185°F— 1000 megohms or greater
At 72°F—50000 megohms or greater

WORKING TEMPERATURE RANGE Minus 50° F to plus 185° F OPERATING FREQUENCY RANGE. . Upper limit 40 megacycles

Q at one megacycle—average 20
POWER FACTOR......At 1000 cycles .004 to .006

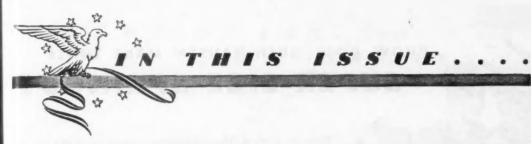
Capacity in MMFD.	DC Working Voltage	TOBE & AMERICAN WAR STANDARDS DESIGNATION	
	Rating	"A" Chara	cteristic "B"
1000	600-1500	CN35A102	CN35B102
1500	600-1500	CN35A152	CN35B152
2000	600-1500	CN35A202	CN35B202
2500	600-1250	CN35A252	CN35B252
3000	600-1000	CN35A302	CN35B302
4000	600-1000	CN35A402	CN35B402
5000	600- 800	CN35A502	CN35B502
6000	600- 800	CN35A602	CN35B602
7000	500- 700	CN35A702	CN35B702
8000	500 - 700	CN35A802	CN35B802
10000	400- 600	CN35A103	CN35B103
20000	200- 300	CN35A203	CN35B203
30000	50- 150	CN35A303	CN35B303
40000	50- 100	CN35A403	CN35B403



A SMALL PART IN VICTORY TODAY

BIG PART IN INDUSTRY TOMORROW





### AUTOMOTIVE and AVIATION INDUSTRIES

Volume 90

April 15, 1944

How to Assure America's Oil Supply

18

Much attention is necessarily being focused on the oil supply of the country, in our attempt to tailor our civilian needs to war time requirements. The fact that much must be done not alone for now, but for the days after the war as well, has been brought into the foreground. This article is made up of verbatim extracts from the preliminary report of the National Oil Policy Committee of the Petroleum Industry War Council and in many features is most revealing and constructive.

Decentralization of Willow Run Bomber Plant

Among the many difficulties experienced when first the Ford organization took on the production of B-24 Liberators and Bombers was the shortage of labor. How they handled a decentralization program that whipped this problem is the subject matter of this article. You must read it.

Production Version of the **Mars Flying Boat** 

The Glenn L. Martin plant is now busy on craft for the fighting forces, but is about to launch forth on an order of twenty aerial freighters. Some changes have been made

in the design. This article is to tell you what the new craft will be like. It is a likely harbinger of postwar models.

Russian PE-2 Dive Bomber

Here is text, tables, illustrations and data on this history making plane. It is really something "for the book."

Repair Techniques for Salvaging Airframes

The author of this article begins with this statement "Salvaging airframes during the process of manufacture has been a matter of grave concern to all aircraft producers." From there he goes on into ways and means that carries the reader from A to izzard. It will answer your queries.



Reg. U. S. Pat. Off.

#### Research and Patents Under the New Deal

By John W. Anderson

President, The Anderson Company

THE ludicrous extremes to which the revolutionists of our Federal Courts are willing to go to accomplish their purpose reflect one of the most alarming symptoms of the psycopathic disturbance from which our nation has been suffering for so many years.

The tortured theory that an invention which arises from joint studies and discussions of progress already achieved in its art cannot be worthy of patent protection is but another reflection of the contempt in which practical experience and its teachings are held by meddlesome, bookish intellectuals-who resent every rigid reality which will not bend to the gossamer of their fantastic formulae.

One of the soundest purposes-and most valuable results-of our patent system has been that it has provided in the published copies of all issued patents, for all who would read, a clear record of the step-bystep progress of the arts, so that by study of, and experimentation with, what has gone before, those public benefactors commonly termed inventors may base their thinking soundly for improvements in any art.

The philosophy from which springs the decision in the Teletype case\* it seems could readily be projected to forbid a patent on any invention conceived by anyone except a hermit denied access to patent office files. to technical magazines, to the telephone and radioand to all companionship and works of man by which might be measured a public need or an opportunity for service

I have often wondered what actuates such judicial revolutionists. Sometimes I think it may be a subconscious conviction that to permit the catalytic institutions of America to generate too much creative and productive muscle might throw into constantly increasing embarrassment, by contrast, those who have not the will to join, or serve, their patient neighbors, in the tedious processes of creation and production-but who prefer, instead, to outwit and discredit those neighbors, while enjoying to the full the fruits of their neighbors' invention and production.

Inventions of the broad economic and defensive significance of those which can come out of such laboratories as those of the Bell System might easily be

(Turn to page 64, please)

<sup>\*</sup>U. S. App. D. C. No. 8189, Jan. 18, 1944. See quotation from the decision at end of article.



Automatic tapering of bar ends prior to coiling

Well-it's this way. Those big babies must be coiled hot, to extremely close tolerances...and produced in quantity at P-38 speed. It's specialized work that demands very specialized equipment. So-Muehlhausen has one huge plant totally devoted to hot forming. It is all conveyorized. Production is governed by a central laboratory. The quenching tanks are the size of swimming pools, and skyscraper-like shot blasters give springs clean, lustrous finish and added life.



Precision hot-coiling springs on automatic equipment



Precision grinding squares both spring ends at once



Shipping finished springs in carload lots

To improve product performance, use

To really appreciate how your production schedule and product can benefit by these extensive facilities, call Muehlhausen in on your next spring job. Write for new booklet on hot-coiling springs.

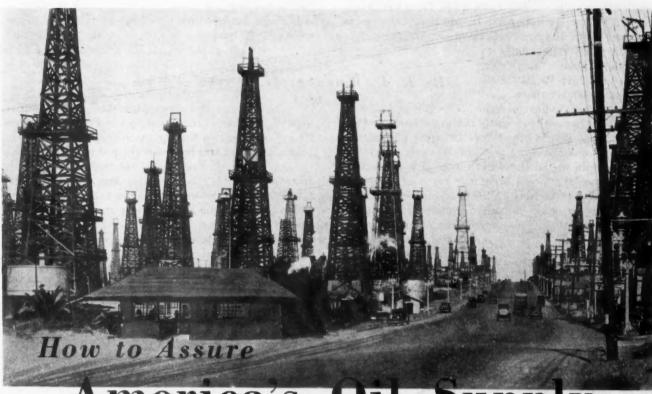
MUEHLHAUSEN SPRING CORPORATION Division of Standard Steel Spring Company
650 Michigan Avenue, Logansport, Indiana

MUEHLHAUSEN Designed SPRINGS

## AUTOMOTIVE and AVIATION INDUSTRIES

Published on the 1st and 15th of the month

April 15, 1944 Vol. 90, No. 8



### America's Oil Supply

CONTINUED vigorous, intensive venturing of capital to keep up the search and to find oil is the most important basic necessity for the future oil production in the United States. Such effort can be carried on effectively only by private venture capital based upon a sound and profitable large-scale domestic oil industry.

Without such continuous oil finding effort on a large scale, all other possible policies are without serious

significance in promoting our future progress in oil. Every proposed policy which may weaken this effort should be rejected.

The oil-producing states of this country have during the past 15 years gradually developed the practice of producing oil in accordance with sound engineering prin-

ciples intended to avoid waste in recovery and this principle has been extended to avoid waste in storage above ground by limiting production within sound engineering practice and within available market demand. These principles of production are referred to as producing in accordance with the optimum-rate and that is the key to sound conservation practices and efficient oil-field operations.

Government should encourage the petroleum indus-

try to assume risks inherent in oil finding and production by minimizing such risks so far as possible. It should not invade the province of industry either by participating with industry in operations or by itself entering into any phase of the business.

As the public interest (Turn to page 96, please)

THIS article is made up of extensive verbatim extracts from the preliminary report of the National Oil Policy Committee of the Petroleum Industry War Council. The Council, it will be recalled, was created by the Petroleum Administrator for War and is composed of 75 of the country's leading oil industry representatives. The document from which this article was prepared is entitled "A National Oil Policy for the United States." The committee announces that it has not completed to detailed studies but has prepared this preliminary statement of principles, here presented in somewhat abbreviated form, at the special request of the Petroleum Administator for War.

RIES

ord's Willow Run Bomber Plant now is manufacturing the big B-24 Liberators on schedule in accepted automotive mass production style. As the largest supplier of B-24 bombers for the Army Air Forces, the huge 67-excre plant near Ypsilanti, Mich., is now producing several hundred bombers a month, according to Ford officials. More than 2000 of the four-engined planes have been flown away from the neighboring Willow Run Airport. In addition, many more knocked down airframe subassemblies are shipped in huge tractor-trailer units to

huge tractor-trailer units to assembly plants at Tulsa, Okla., and Fort Worth, Tex., for final assembly there.

But this attainment of volume output has not been easily achieved. Early in 1943 Willow Run was in the throes of many difficulties.

Manpower was the No. 1 problem. Workers were difficult to obtain in the tight Detroit labor market. And among those that were hired the turnover rate was excessive due to inroads of the draft and enlistments upon male personnel as well as inadequate housing and transportation. Necessary design changes by the

> AAF also were numerous due to shifting combat requirements, and these did not help volume production.

By E. L. Warner, Jr.

Seeking a way out of their manpower dilemma, Ford officials decided to make use of available space and labor in other Ford plants. If enough workers could not be brought to the job, the job would be taken to the workers. First such move was made March 12, 1943, when the tools and fixtures for manufacturing the outboard fuel accessory doors were shipped to the Ford branch plant at Hamilton, Ohio. This plant, which turned out automobile wheels before the war, is about 250 miles south of Detroit. Additional fixtures then were shipped to Hamilton and on April 12, just one month later, the first finished

parts, island doors and landing light doors, were received at Willow Run from Hamilton.

On the same day the first parts arrived from Hamilton, the stabilizer

assembly job was farmed out to the Ford Rouge Tire Plant. All the tire-making machinery and equipment from the latter plant had been shipped to Soviet Russia under lend-lease in the fall of 1942, making the factory space available for bomber airframe work. The stabilizer assembly job involved more than 1100 workers and required 20,000 sq ft of floor space. Fixtures for the fin and elevator subassemblies also were sent to the Rouge Tire Plant in the next two months. Meanwhile, additional space was made available at the Lincoln Plant when the contract for amphibian jeeps was completed in April. Lincoln had been fabricating the hulls for these vehicles. Fixtures for engine dress-up were moved from Willow Run to Lincoln April 17. The first engine dress-up parts were received at Willow Run three weeks later. The engine cowling job was shifted to Lincoln April 27.

A B-24 in knockdown form is laid out on the apron of the Willow Run bomber plant airport before being shipped to an aircraft plant in the Southwest for final assembly. Most of the necessary furnishings, including wiring, tubing and controls are already installed in the assemblies. To the left in the background are completed bombers. To the right of the knockdown is a hangar which a c c o m m o d at e s 16 bombers.

## Decentralization



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### of Willow Run

Fuselage sections moving towards the final assembly line at the Willow Run bomber plant. At the upper left and lower left fuselage sections are assembled. At the right the nose and aft sections move on a conveyor toward the final assembly line while workmen make last minute installations.

### Bomber Plant Results in Volume Output

In July Ford was informed that the contract for medium M-4 tanks would be terminated, effective Sept. 15. As this war contract utilized much space at the Ford Highland Park Plant, it meant that labor and facilities would be idle there. It was decided to transfer the B-24 outer wing job from Willow Run to Highland Park. This was the largest job moved away from Willow Run, involving as it did nearly 2000 employes and 95,000 sq ft of floor area. The first outer wing fixtures were sent to Highland Park Aug. 13 and the first completed outer wing was received from there Sept. 28.

Additional jobs farmed out to other Ford plants include nose side panels, fuselage tail cones and various hydraulic assemblies to Highland Park, center wing bulkheads, nose rings and air ducts to Lincoln; landing

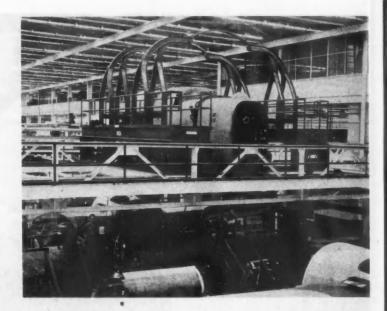
gear assemblies, fuselage canopies, tail assemblies and ailerons to the Rouge Tire Plant, and the radio operator's floor, fuselage side panels and truss bulkheads to the Rouge "B" Building.

But the decentralization of bomber parts and sub-assembly production from Willow Run was not confined to other Ford plants. Outside companies were called in to bid on some of the subcontracting jobs. First of these to be farmed out was the pilot's glazed enclosure. Fixtures for this job were shipped April 14 from Willow Run to the Pittsburgh Plate Glass Co. at Crystal City, Mo. Five weeks later, on May 22, the initial pilot's enclosure arrived from the Missouri plant. Many other parts and subassemblies also were subcontracted until 33 companies now are engaged in this work for Willow Run. They range from large con-

cerns like E. G. Budd Co. and Gibson Refrigerator Co. to small tool shops and a Ford dealer in Detroit. Some are located as far away as Birmingham, Ala., and Creighton, Pa., but the majority are in Michigan—a number in Detroit. and others in Jackson, Menominee, Niles, Trenton, Wyandotte, Grand Rapids, Holland and Albion.

This decentralization program has helped materially to relieve the manpower shortage at Willow Run. It eliminated the need for more than 22,000 employes at Willow Run and, incidentally, made available more than 800,000 sq ft of floor space at the bomber plant. This latter was not a factor in the decentralization program, however, as Willow Run's floor area has always been adequate. Willow Run's em-

ployment actually has declined in the last eight months. From a peak of 42,000 employes in June, 1943, it dropped to 35,500 in January, 1944. This is in marked



contrast to earlier Government estimates of peak employment ranging from 70,000 to 100.000 workers. Of course the decentralization program accounts for

some of this decline but the increasing efficiency of the workers on the job, which has cut the average manhours per bomber from 200,000 on the pilot models to less than a quarter of that number, also is a big factor. Employment requirements have dropped so far from some early estimates that there are several thousand vacancies in Government housing projects near the Willow Run.

Labor turnover, which averaged 6 per cent a month early in 1943, climbed to 8.79 per cent at Willow Run in August, when the summer wanderlust prompted many of the workers to go elsewhere. Turnover then declined, but hit a temporary peak of 9.47 per cent in November. This is attributed to the first cold

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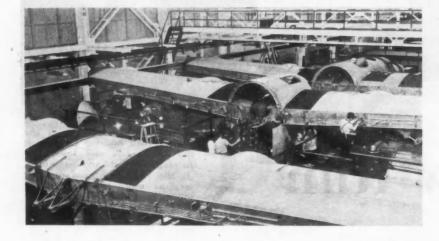
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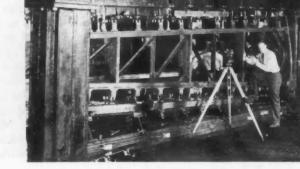
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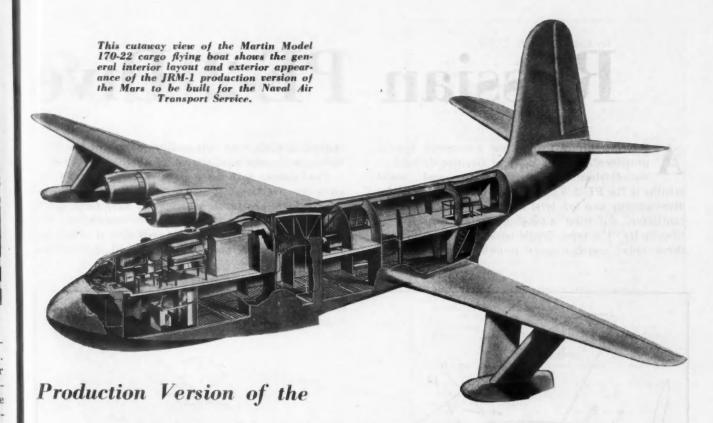
wave of the winter, which sent many in-migrant workers from Kentucky, Missouri and other southern states trekking back to their homes in the South. Labor (Turn to page 85, please)



(Above) Beginning of the Willow Run final assembly line. Four primary lines such as is pictured here, merge into two final lines after passing through the initial stages of assembly. The center wing section moves from station to station at this point by conveyor. At the first station shown, the fixture provides for the installation of the cat-walk and the bomb racks. At the second, the side panels are placed in position and beyond, at the third, the forward fuselage section is mated.



(Right) Checking one of the wing fixtures at Willow Run with a master dummy before placing it in production. The fixture shown is used to assemble the right hand outer wing panel, and was designed by Ford engineers to facilitate quantity production. Same method for checking fixtures was used when they were moved to Highland Park on this job.



## Mars Flying Boat

THE Martin JRM-1, production version of the 70ton Mars, will be even larger and more efficient than the prototype now in Navy service in the Pacific. Twenty of these huge aerial freighters will be built for the Naval Air Transport Service by The Glenn L. Martin Co. External changes on the new production model will include substitution of a single rudder tail for the twin-rudder tail on the prototype, lengthening of both the bow and second step by four feet to provide added cargo space, and the enlargement and redesign of both main and rear cargo hatches. Inside, the giant hull has been stripped of shower baths, pressurizing equipment, mess tables and lounges which were included when the big ship was first designed as a patrol bomber. One bulkhead has been removed completely and frames with openings wide enough to permit the passage of jeeps, field guns and aircraft engines substituted for the remaining bulkheads on the main cargo deck. The number of bunks has been reduced from 36 to eight, four of which are located on the flight deck in the space formerly occupied by the pilots lounge, and four on the upper rear deck just aft of the auxiliary power plant compartment

New equipment on the JRM-1 includes more than a ton and a half of tiedown fittings, skid strips and engine dolly tracks, a 5000-pound capacity cargo hoist on an overhead track running out on both wings, and a stairway to the upper rear deck to permit its use for litter cases. While primarily designed for cargo carrying, the JRM-1 has built-in fittings which will permit its instant conversion into a hospital ship, a passenger transport or a troop carrier. In the first category it will accommodate 84 litter cases with 25 attendants; in the second, 50 passengers in reclining chairs, all on the lower deck; and in the third, 132 troops all seated. As a cargo carrier the JRM-1 will have ample space for seven jeeps and greater numbers of field guns or aircraft engines.

Four cargo hatches are provided for loading the JRM-1 as against three in the prototype. There are two main hatches, one under each wing, 99 in. wide and 92 in. high. Each of these hatches is closed by vertically-divided doors, opening outward, which are completely independent of the hoist, a self-contained unit that can be run to either side without any rerigging.

The two aft cargo hatches are located on either side of the airplane just forward of the second stop. They provide openings 50 in. wide by 62 in. high and have doors which slide up inside the hull when open. Immediately above the aft hatches are trap doors 50 in. by 24 in. for loading density cargo onto the upper deck.

The main cargo deck has a plywood floor with a built-in grid of 3000 pounds capacity tie-down fittings running both fore and aft and athwart ships on 30-in.

(Turn to page 104, please)

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## Russian PE-2 Dive

RUSSIAN aircraft that has frequently figured prominently in the news of German defeats on the Eastern Front during the past twelve months is the PE-2, a machine designed primarily for dive-bombing and low level attack. It is an all-metal, cantilever, mid-wing monoplane with two 1100 hp 12-cylinder Vee-type, liquid-cooled engines driving three-bladed, constant-speed propellers with electrical

control of pitch. An outstanding feature of the PE-2 design is the electrical control of auxiliary services.

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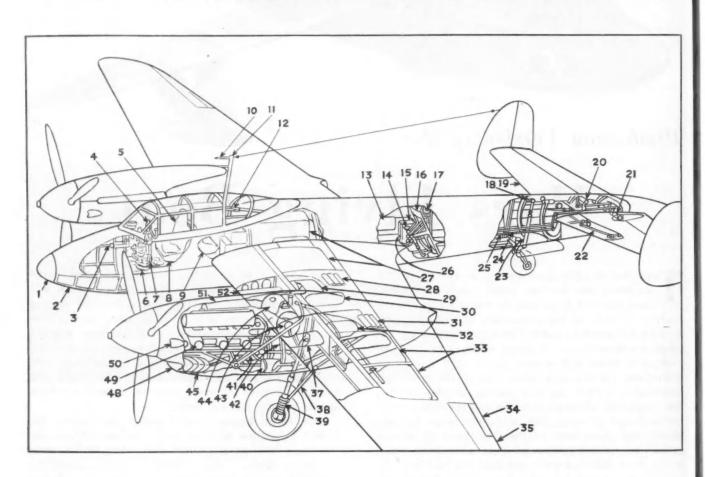
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The fuselage is in three parts, of predominantly circular cross section, and has a twin tail unit. All control surfaces are fabric-covered and have electricallyoperated trimming tabs. The accommodation and location of the crew of three is somewhat unusual, for the pilot and radio operator normally sit back-to-back



### Cutaway View of Russian PE-2 Dive Bomber

Reproduced from copyrighted drawing by Plyg (Sweden) and Interavia (Switzerland).

- 1. Perspex (Plexiglas) nose
- Flat bottom glass Starboard fixed 12.7-mm. cannon
- Brake lever Back armor
- Rudder pedals Elevator control socket
- Pilot's sear
- Radio operator's seat
- Pressure head
- Wireless mast
- Upper mobile gun

- Windows Lower mobile gun
- Magazine
- Retractable gun cradle
- 17. Reflector sight

- Tail wheel retracting gear Tail wheel operating ram 19.
- Elevator coupling
- 21. Elevator yoke 22.
- Rudder pushrod
- Tail wheel shock absorber 23.
- 24. Elevator pushrod
- Rudder pushrod 25.
- 26. 27. Cartridge belt
- Fuel tanks 28.
- Radiator gills Engine radiator 29.
- 30. Gas seal piping 31. Radiator gills
- 32. Engine radiator
- uel tanks 34 Ailerons trimming tabs

- Aileron 36. Undercarriage strut
- Radiator air duct 37.
- Undercarriage strut Shock absorber sealing sleeve
- Blower air intake (supercharger) Engine bearers
- 41.
- 42. Engine radiator air intake Oil filling plug
- 44. Oil tank
- Oil radiator
- Radiator gills operating motor Oil radiator gills 46.
- 48. Oil radiator air intake
- Carburetor
- Cooling air intake 50.
- 51. Pressure oil tank52. Engine radiator air intake

### Bomber

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in the cockpit, while the gunner is located in a prone position in the belly of the fuselage between the wing and the tail unit, with his guns fired backwards and downwards after being extended through an aperture in the bottom of the fuselage and aimed by means of a reflector sight. There are three variations in armament, though all include two "fixed" guns projecting forward above the nose of the fuselage. The radio

operator has a second duty in serving also as bomb-aimer, in which capacity he lies prone below the cockpit with



through the Plexiglas (Perspex) paneling of the nose.

As shown in the accompanying tabulated data, the PE-2 has a maximum speed in level flight of 335 mph at

16,400 ft, the maximum permissible diving speed being 450 mph. With dive brakes in operation the maximum diving speed is 370 mph.

The type of engine used is known as the M-105R (R signifying reduction gear). The twelve cylinders, in banks of six set at 60 deg, have a bore of 5.83 in. and stroke of 6.7 in., giving a total piston displacement of 2140 cu in. The compression ratio is 7 to 1 for 94-95 octane fuel. Six pressure type carburetors are fitted.

There are three valves per cylinder (1 exhaust and 2 inlet). The valve operating mechanism consists of an overhead camshaft for each cylinder block,

This description of the Russian PE-2 warplane, designed by digineer Petlyakov, is based on a recent article published in yg (Sweden) and translated by the British Air Ministry. The ticle in Flyg was written by the Swedish aircraft engineer, ils Hulten. Another version of this airplane, the PE-3, is uipped with a power-operated gun turret at the rear of the exhit hood. uipped with ekpit hood.

#### PE-2 Specifications

#### Dimensions

Length	42 ft.
Wing Span	56 ft.
Wing Area	435 sq. ft.
Equipped Weight	13,000 lb.
Loaded Weight: standard	17,000 lb.
maximum	18,750 lb.
Wing Loading	40 psf.
Fuel Capacity	396 U. S. gal.
Lubricating Oil Capacity	48 U. S. gal.

#### Performance Maximum Speed :16,400 ft..... 335 mph

6500 ft	315 mph
sea level	280 mph
Cruising Speed	250 mph
Speed on one engine at 3000 ft	175-185 mph
Time to climb to: 10,000 ft	3½ min
16,000 ft	7 min
3000 ft	7 min
(one eng.)	
Theoretical Ceiling	33,000 ft
Service Ceiling	29,500 ft
Landing Speed	93 mph
Max. Diving Speed (brakes on).	370 mph
Max. permissible Diving Speed	450 mph
Optimum Diving Angle	50-70 deg
Loss of Height in Pulling-out	2,000-3,000 ft

#### Engine Data

314-3 hours 600-900 miles

Range .....

Endurance .....

Type	M-105R,	liquid-cooled,	12	cylinder
	60 des	z. Vee		

73 7 7	
Bore and stroke	5.83 in. by 6.7 1
Piston Displacement	2140 cu in
Compression ratio	7 to 1
Fuel	94-95 octane
Length	78% in
Height	
Width	30½ in
Weight	
Specific weight	

#### **Engine Performance**

	Take-off		imum eed		ising eed
Engine Hp	1100	1100	1050	900	945
Engine RPM	2600	2700	2700	2800	2600
Altitude	Sea level	6500	13,000	6500	13,000
Boost, atm gage	1,29	1.235	1.235	1.24	1.24

The Russian PE-3 dive bomber, which is similar to the PE-2 described in this article.

A major difference on the PE-3 is the gun turret at the rear of the cockpit hood.

actuating the exhaust valves directly and the inlet valves by means of rockers. The two-speed supercharger has gear ratios of 1 to 7.85 and 1 to 10 with electrical control. Propellers are of the "Wisch-61" type, three-bladed all-metal with electrical pitch setting and constant-speed governor. The propeller drive is described as "spur gear with floating follower wheel" giving a reduction ratio of 1.694 to 1.

Below each engine is an oil radiator, a crescentshaped cellular unit of brass, with an electrically-controlled throttle flap for regulating the cooling air flow. There are two coolant radiators for each engine, fitted

(Turn to page 102, please)

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THE Society of Automotive Engineers is expanding its activities in the aviation field to include an Air Transport Engineering Activity, President W. S. James announced at the National Aeronautic Meeting of the Society which was held April 5-7 in New York City. William Littlewood, American Airlines vice-president, was named chairman of the new Activity. President James reviewed the important services being rendered to the aviation industry by the SAE, one of its major contributions being made through a program of dimensional standardization and materials specifications in the aeronautical field, which is in addition to the Society's Aircraft and Aircraft Engine activities.

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#### Measurement and Prediction Of Aircraft Vibration

B. E. F. Critchlow,

Chief, Flutter & Vibration Unit, Aircraft Engineering Division, Civil Aeronautics Administration

THE increasing size, cost and performance of aircraft make it imperative that analytical methods be developed for accurately predicting flutter speeds. The methods of Kussner, the classical theory of Dr. Theodorsen of the NACA, the extensive work of Major Smilg of the Army, the Bureau of Aeronautics of the Navy and other researchers permit the determination of the critical speed once the frequencies and modes of vibration of the components of the airplane are established. In this paper the author first describes and classifies equipment which permits the determination of these frequencies and modes of vibration after the aircraft is built. Secondly, he outlines an analytical and tabulating machine method for determining these frequencies and modes in the design stage.

Some idea of the range and utility of the various types of vibration measuring equipment can be obtained from Fig. 1. This spectrum shows the range wherein various types of aircraft vi-

Daylight precision bombing is America's greatest offensive contribution to this war, Major General Frank O'D. Hunter, Commanding General of the U. S. First Air Force at Mitchell Field, told the SAE members. General Hunter stated that the United States now has 15 Air Forces, six of which are on the North American Continent, including four Air Forces in this country.

Costas Ernest Pappas, chief of aerodynamics, Republic Aviation Corp., received the SAE Wright Brothers Medal awarded to him for his outstanding contribution to aerodynamics in 1943. The presentation was made by Peter Altman, chairman of the Wright Brothers Medal Board of Award.

Close to 1000 company engineers and aeronautical specialists from government agencies and the Armed Services were in attendance during the three days. Twenty-three papers on current design and production problems in the manufacturing and operational fields of aviation were presented at twelve sessions, during which engineers from various sections of the country pooled their ideas and experiences. Abstracts of a number of the papers are given herewith; others will be published in early issues of Automotive and Aviation Industries.

brations occur and gives some idea of the equipment that might be used for measuring them. Brief descriptions and a list of manufacturers of each of the various types of instruments are given.

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Since available methods for calculating coupled modes of vibration were long and tedious, the Aircraft Engineering Division of the CAA initiated a study aimed at devising an additional tool for the engineer to expedite such calculations. After considerable exploratory work, methods of utilizing the punch card calculating machines were successfully developed to perform the laborious calculations involved. After procedures were developed for utilizing these machines on calculations at zero airspeed, the procedures were then extended to permit computations of modes of vibration at various airspeeds and to solve the basic flutter equations involved in the determination of critical flutter speeds. All methods of analysis touched on in the paper will be presented in a CAA report which will be issued in the near future.

For the determination of dynamic loads in aircraft the same electronic equipment as is used for vibration studies may be used. Furthermore, the same mathematical tools are applicable,

the analysis presented here yielding either the steady-state vibrating conditions of the structure or the transient conditions which determine the dy-

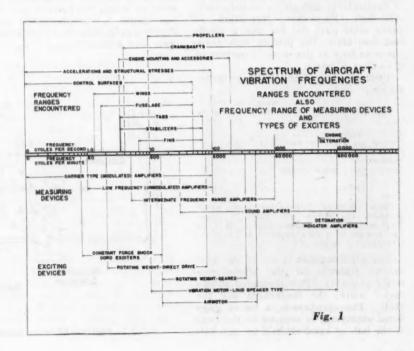
namic loads. In many large airplanes of the future it will be necessary to accurately predetermine these dynamic loading conditions, since the savings in weight possible with an accurate knowledge of these conditions will be significant.

#### The German VDM Electric Propeller

By John D. Waugh, Lockheed Overseas Corp., British Isles

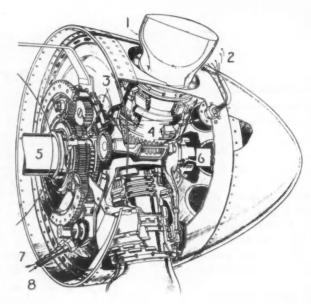
THE VDM electric propeller is designed and built by the Vereinigte Deutsche Metallwerke, Aktiengesell-schaft, of Frankfurt-am-Main, Heddernheim, and Hamburg, Gross-Borstel, Germany. This engineering company has spent many years of research and development on its propeller and has refined it to the point that it is used almost exclusively on all types of operational aircraft in the Luftwaffe. The exceptions are the Junkers hydraulic motor operated propeller and the Argus aerodynamically operated These propellers have a more type. limited range of adaptability than the VDM and are thus used less widely.

There are two types of installations of the VDM propeller in Luftwaffe aircraft: (1) The non-automatic installation has both mechanical and electrical pitch indicators and depends upon pilot selection to operate the propeller at all times. This installation can be converted to automatic operation. (2)



#### Fig. 2—Cutaway view of V D M propeller (copyright "The Aeroplane" England).

- 1—Blades are effective right down to root.
- 2—Centrifugal force throws glycol antiicing spray out onto blade.
- 3—Spinner fixing to air screw hub.
- 4-Worm drive
- 5—Air screw shaft from motor.
- 6-Hollow shaft allows for cannon mounting.
- 7-To limit control.
- 8 —From electric driving motor.



The automatic installation incorporates electrical and mechanical pitch indicators, a governor, and a relay, and will operate in constant speed after a fashion. (For details of the VDM mechanism, a reference in addition to Mr. Waugh's paper is the article, "VDM Propeller Pitch Changing Mechanism," in the Feb. 15, 1943, issue of AUTOMOTIVE AND AVIATION INDUSTRIES.—Ed.)

Fig. 2 shows the general arrangement of the component parts and driving mechanism. Since the motive power for blade displacement is led to the propeller by a flexible shaft it is obvious that any means of rotating the shaft will serve the same purpose as the reversible electric motor located on the engine crankcase. Accordingly, the VDM people made known that their propeller can also be supplied with hy-

No part of this propeller mechanism is particularly difficult to manufacture. Although Magnaflux inspection of every steel part did not find a single bad indication, the process took three times as long as the same inspection of a Curtiss Electric.

draulic, pneumatic, mechanical, or

manual means of operation.

Unit weights of the VDM propeller follow:

Units	eight lb.	Pro- peller oz.
Hub	46	6
Blade mountings (3)	65	4
Blades (3) (111/2 ft. diam.)		-
Gear box		4
Spinner		6
Motor, gov., relay system.		3
Total	270	7

(Note: Missing installation parts would probably not weigh over 10-20 lb. more. This propeller was taken from a BMW 880 hp. engine of a twin-engined Heinkel 115 mine-laying seaplane.)

The VDM spinner is one of the most unique features of the whole propeller assembly. It is composed of two major units; the diaphragm and the shell. The diaphragm, a heavy gage dural stamping, is secured to the rear of the hub by brackets held to each hub

socket by six cap screws. At the outer circumference of the diaphragm a series of screws hold in place and allow limited rotation of a locking ring equipped with 21 keyhole slots designed to align exactly with 21 holes in the diaphragm when the locking ring is turned so that the round part of the keyhole slot is over the diaphragm hole.

The spinner shell is formed of two pieces. The back half is flanged at its rear and recessed to accommodate the three blades. The center baffle is spun from the same piece of sheet dural which forms the back half. To this back half the domed front is flush riveted. A bakelite ring is secured to the center of the support baffle by a riveted channel ring. The flange on the rear shell half has a series of holes punched in it which coincide with 'the stud projections of the diaphragm and 21 groove-necked studs which align with the locking ring holes. Only a matter of seconds is necessary to remove or install the spinner and that it has merit is demonstrated by the RAF's application of its principles to their own aircraft.

#### **Power Boost Flight Controls**

By E. G. Riley,

Project Engineer, The Glenn L. Martin Co.

The largest size airplane which can be operated without power boost is controversial, but it is safe to assume that on an airplane of approximately 150,000 lb gross weight or over, a power boost control is desirable if not essential. In all probability, an allelectric boost control system could be designed to fulfill requirements, but all that were investigated for the 140,000 lb gross weight Martin Mars airplane proved to lack one or more of what was considered essential characteristics. For this airplane, a relatively high pressure hydraulic system was decided upon, since with the high pressure, large forces could be obtained using fairly small cylinders and other component parts, and it complies with all requirements.

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Fig. 3 schematically shows the positioning of the Vickers servo cylinder and the booster cylinder in relation to the elevator control system. The scissors linkage shown serves as the actuator for the servo valve piston as well as the manual stand-by feature. operation cycle of the control system is as follows: assuming the elevator surface to be held in its neutral position by equal airloads from above and below, the pilot begins to move the control surface upward by moving the control column back. The first slight motion of the control column aft rotates link "P" about point "L." Since the elevator surface is held in a neutral position by airload, link 'S," which is pivoted on the airplane structure, does not move. Rotation of link "P" pushes the servo valve piston aft. Hydraulic fluid under pressure is admitted to the booster cylinder causing the elevator to move up against airload as the control column continues to move aft. As the down airload on the surface increases, pressure builds up in the booster cylinder. It also builds up in the servo valve cylinder, thus pro-

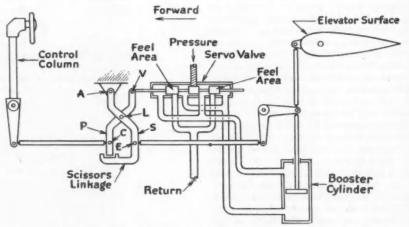
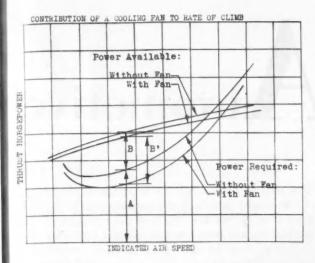


Fig. 3-Elevator control system incorporating boost unit.



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Fig. 4—Contribution of a cooling fan to rate of climb.

viding a proportional load on link "P" and on the control column. As the elevator moves up, link "S" is rotated about point "A", thus moving pivot point "L." The control column moves aft at the same rate as the elevator surface moves up so the distance be-tween points "C" and "E" remains constant. (Note: Fig. 1 is diagrammatic. Actually, points "A" and "V" and also "C" and "E" must be on common centerline.) When the pilot stops moving the control column, the elevator continues to move momentarily because fluid is still being supplied through the open servo valve to the booster cylinder. The additional movement of the surface rotates link "S" about its pivot point "A." Point "C" is held motionless by the control column, however, and point "L" therefore moves forward pulling the servo valve piston closed. Under this stable condition, the down airload on the elevator surface is resisted by a pressure in the lower end of the booster cylinder which is greater than that in the upper end of the cylinder. This same pressure is transmitted to the servo valve piston which through the linkage acts on the control column tending to move the column forward. The pilot must must hold against this load. Should the pilot release the control column, the servo valve piston would then be allowed to move so as to relieve the excess pressure. This in turn would relieve the pressure exerted on the booster cylinder and allow the elevator surface to return to neutral. Should the control column be left free, it will in turn leave the servo valve piston free to be moved in either direction. Obviously, the piston will not remain in any position unless the pressure in each end of the cylinder is the same. If this pressure is equal, the load on either side of the surface must also be equal.

Actually a noticeable amount of motion of the control column is not required to open the servo valve before fluid could be supplied to the booster cylinder. Fluid is supplied through the pressure line at a constant pressure of 1500 psi. It takes a motion of only ap-

proximately .005 in. to start bleeding fluid through the valve and begin movement of the control surface. A total motion of 1/8 in. is provided and this supplies fluid at the rate far in excess of any ever needed for the most rapid motion of the surface. Thus immediate response is satisfactorily provided. The pressure source used is a variable volume pump electrically driven. Two identical units were provided-either of which has sufficient capacity to operate all three control surfaces simultaneously. One hundred per cent stand-by for the power source is thus provided. An unusual feature is provided in the automatic by-pass valve. The valve was made into a combination by-pass and lock valve. It is so arranged that by inserting a key, it is possible to turn the valve and trap fluid in each end of the booster cylinder.

This power boost system can be operated by a conventional automatic pilot. By placing the autopilot ahead of the valve linkage, the power boost reacts to loads from it the same as from the human pilot.

### **Engine Cooling Fan Theory and Practice**

By Kenneth Campbell, Senior Project Engineer, Wright Aeronautical Corp.

THE application of cooling fans for the purpose of reducing the thrust horsepower consumed in air cooling of aircraft engines offers worthwhile and, in many cases, very large improvements in rate of climb, in top speed at high altitude, in top ceiling and single-engine ceiling, in useful load, or in cruising economy.

A fan helps most when  $\Delta P/q$ , or the ratio of drop in total head through the cooling system to the total initial flight dynamic head available, is high, which is the case when cooling conditions are marginal. Therefore the benefit of a fan is greatest in climb, or in level flight near ceiling. Fig. 4 shows a typical pair of airplane power-required and power-available curves. The ordinate B determines the rate of climb at

any indicated airspeed, since it is the power left over to raise the weight of the plane after deducting ordinate A, the power required to fly level at that airspeed. Application of the fan reduces the power available by a certain small increment, but at a high value of  $\Delta P/q$  application of the fan also reduces the power-required curve by several times this increment, resulting in a net gain in power, B', available for climbing, with proportionately increased rate of climb. In many cases, a fan should improve the rate of climb 20 per cent—in extreme cases, more.

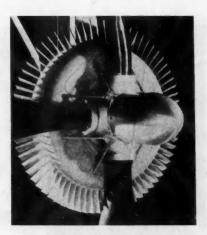


Fig. 5—Complete installation highaltitude geared fan.

Ceiling, likewise, benefits materially from a little boost of thrust horse-power. Since ceiling also is one of the high  $\Delta P/q$  operations, involving marginal cooling and reduced indicated speed, it stands to gain much, with rate of climb, by fan application. The two-engined transport, whose single-engine ceiling leaves a good deal to be desired, or the overloaded bomber offer interesting possibilities for application of this principle in improvement of ceiling.

Fig. 5 shows a fan installation de-(Turn to page 172, please)

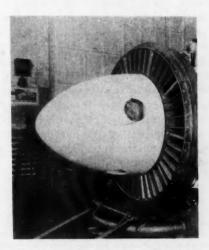


Fig. 6—Close-up of propeller-speed fan for flying boat installed on propeller.

# AC Uses Automotive

Some months ago we had the privilege of describing briefly the manufacture of the automatic pilot by this organization. It marked the first time that this type of mechanism had been adapted to mass production.

At this writing we have undertaken the highlights of an equally Gargantuan task—volume production of the "T-1" British bombsight. First announcement of this was released to the newspapers some time ago

after thousands of the instruments had been delivered safely to our allies. The "T-1" is an amazing device de-

(Left) Close up of work station of one of the ExCell-O precision boring machines on the bombsight line, this one being of double-end, four-spindle type. By suitable arrangement of work holding fixtures, it is feasible to bore a multiplicity of holes in relatively different axes in the same machine and without disturbing the tooling.

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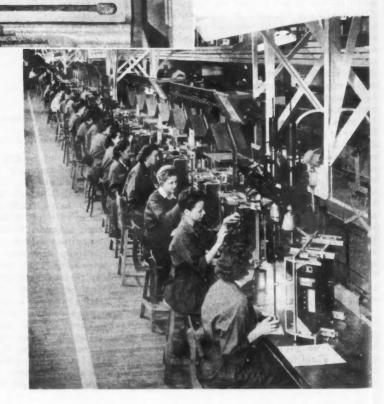
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ECAUSE of its breadth of experience in the development and manufacture of instruments and many items of precision parts for the automotive industry in normal times, the AC Spark Plug Division, General Motors Corp., is currently engaged in the production of some 459 different products for the war. Out of this background and particularly because of specialization which has given the organization its unique ability to translate intricate designs into mass production techniques, AC has undertaken the manufacture of parts not only foreign to the experience of the automotive industry but, in some instances, new to any industry in this country.

Bombsights in mass production at AC. Here is the beginning of the computer assembly. Note the housing held in a rigid fixture to preserve accurate alignment through all the stages of initial assembly. Operators install the various sub-assemblies as the housing, held in the fixture, progresses along the line.



Lethods

to Speed Output of T-1 Bombsights

(Below) Threaded parts for the bombsight are produced by precision thread grinding on a battery of Jones & Lawson thread grinding machines such as this one. Standard equipment for each machine is a Pratt & Whitney Electrolimit gage which permits the operator to check her work.



(Right) Typical of the ingenuity displayed at every turn is this overhead suspended drill press station, consisting of Black & Decker portable drills mounted as shown and fitted with quick drop handle which starts the motor simultaneously. This arrangement provides for space economy and speed.

signed for relatively low altitude night bomber operations. It is free of optical complications and is essentially a predictor type of bombsight as contrasted with the Norden "preset" type. It consists of two separate units—the sighting head, and the computor, the latter being the subject of this study.

Actually AC was asked to start this project before Pearl Harbor and received its first order for five experimental models early in 1942. These were delivered six months later—a product of AC's experimental department. However, the tooling program was initiated immediately so as to aim for mass production at the earliest possible moment.

Opening phases of this development included a study of the basic details supplied by the British, followed by a complete redesign and conversion to automotive production methods. One of the fruits of this activity was a reduction in the number of parts from the original 1120 pieces to 840 pieces. Considering the actual combination of these 840 pieces, the finished product contains 4200 parts. Many of these are held to tolerances

The basic locating holes required for subsequent drilling operations on the main frame are drilled to precise location on one of several Walker-Turner radial drills.





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ranging from 0.0002 to 0.0008 in., depending upon the function of the part.

In the engineering analysis, AC took fullest advantage of aluminum, and decided upon the use of high pressure die castings throughout so as to minimize waste, reduce metal removal, and increase accuracy. Needless to say, AC's recognized position as one of the foremost exponents of die casting techniques placed the company in good stead.

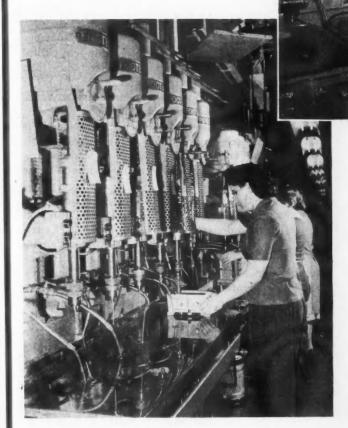
Next it was realized that the instrument must be redesigned for progressive assembly operations. This resulted in the development of functional sub-assemblies, permitting the assembly and testing of individual components, and the localizing of problems of intricate assembly operations. This, in turn, reduced final assembly operations simply to the attachment of individual units to the main base housing, lining them up properly, pinning each one in its proper place, and the final timing and calibration of the assembly as a whole.

It was recognized that due to the need for immediate action, assistance would have to be sought from outside specialists serving as sub-contractors. To facilitate this, sub-contractors were presented with the task of producing an individual sub-assembly as a complete unit. It could be built, assembled, tested, and shipped as a unit which, after suitable inspection and adjustment at AC, could be installed as a unit without further work. A combination of fortuitous circumstances aided, primarily, by a judicious choice of vendors, made this principle work and it has continued to work without any change in sources.

One example is cited to illustrate the value of specialized know-how. It was found that although most British planes had available a source of high pressure air and vacuum, some types would have neither and it became

(Right) Part of one of a number of sub-assembly benches in the assembly department. This is the trail cam assembly bench showing one operator drilling and reaming with Delta drills while the other is making adjustments for parallelism.

(Below) One of many Footburt sixspindle drill press set-ups in the machine shop. Drilling and tapping of the small die castings is deliberately subdivided into single-stage operations such as this in order to prevent distortion or warpage.



the largest aluminum high pressure die casting ever made, requiring 14 pounds of metal, replaces a steel plate

in addition to two steel stampings.

The variable pitch trail cam in its original design was machined to form and required checking to 0.005 in. at 500 points. In the AC design it is molded from Bakelite of special composition and requires no further machining save for the tapping of two holes in each end.

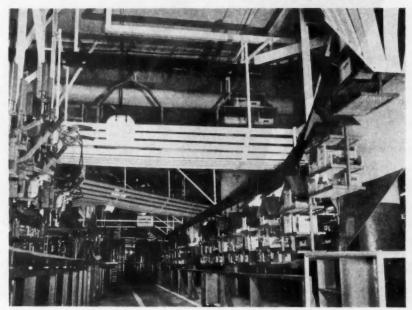
The rubber wheels in the servo stop, start, and reverse direction 110 times per minute. They must not wear rapidly and are required to carry full load without slipping at all temperatures between minus

(Turn to page 90, please)

(Below) One section of the 1600-foot monorail system installed by Jervis B. Webb. This view shows the type of carriers employed on this line and the general character of the wood trays which hold component parts.

necessary to provide a self-contained source to meet this situation. Some time back, AC had been experimenting with a variation of its well-known fuel pump to adapt it as a fuel meter handling about 700 gallons of fuel per hour. No immediate application appeared for the fuel meter. But it turned out to be exactly what was needed for the bombsight.

Now for a few highlights of the initial design problems. In the first place, the weight of the British instrument was 85 pounds. By redesign and by the utilization of lightweight aluminum die castings, the weight was reduced to 55 pounds. For example, the main base casting,



### Repair Techniques for

# Salvaging

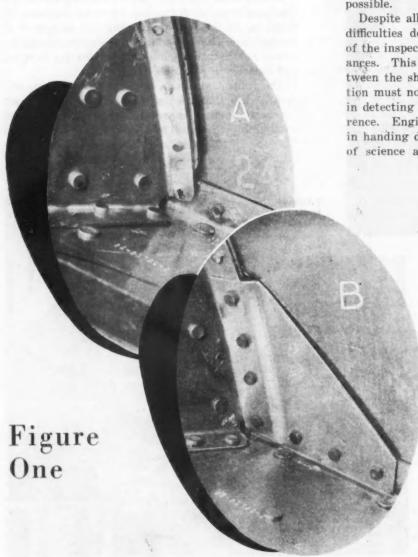
Salvaging airframes during the process of manufacture has been a matter of grave concern to all aircraft producers. Before Pearl Harbor, the question of quality was paramount and frequently damaged parts and assemblies were unhesitatingly scrapped. Today, with our nation at war, the question of serviceability has superseded quality which

bespeaks of expert craftsmanship. This is obvious when it is remembered that there are far less skilled man-hours consumed in building aircraft today than in the previous era. The craftsman of those days is the foreman of today, while new and inexperienced workmen form the modern aircraft workers. Today, when greater emphasis is placed on production, it is a fact that in each plant a small group of responsible inspectors and engineers keep vigil on maintaining as high a standard of quality and serviceability as possible.

Despite all the careful preparations that are made, difficulties do arise and it is primarily the function of the inspection department to locate and report variances. This calls for teamwork of the first order between the shop, inspection, and engineering. Inspection must not relax its vigilance and careful scrutiny in detecting errors and cooperate against their recurrence. Engineering must be the sole judge and jury in handing down a final decision where the principles of science and design are in jeopardy. The latter

interest cannot be influenced by anything except the application of basic or sound principles.

In making an analysis of the damage, it is too often the case that only the local effects are investigated without regard for the far reaching effects on the completed assembly. On the one hand, the local effects may concern a series of poor rivet holes, whereas the overall effect on the assembly would mean a redistribution of shear transferred from one web to another. In like manner, the attachments of stringers to bolting angles is worthy of attention. While the attachment of a single unit may be a local



(A) Result of insufficient edge distance in a frame flange at its junction with another flange. (B) Method of repairing the damage by means of a formed corner gusset which, in this case, even supplies a higher degree of rigidity than existed in the original design.

Airframes

matter, the overall effect on the bolting angle would be a redistribution of the load normally carried by the stringer to adjacent members. The latter may already be loaded to a maximum. While it is not expected that items requiring extensive repair will be dealt with during manufacturing, it must be remembered when such is the case that the overall properties of the shell type structure are to be kept intact. It is possible, when repairing a wing for major damage, that replaced oversized ringers, if permitted to extend over a considerable portion of the span, will affect the entire bending rigidity of the wing panel.

Prior to any repair, it is essential that extensive inspection be carried out to guarantee that all critical items have been considered. It is the duty of the inspection department to carefully establish the fact that all damage has been found and accounted for. In making minor repairs (and in these may be included repairs that occur most frequently), it is

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possible that the inspector alone, with the aid of a Structural Repair Manual, may designate the type of repair to be made. The inspector must be able to detect the similarity between the damage at hand and the one illustrated in the manual for which a standard repair exists. With proper interpretation, the inspector may apply the general repair to very slightly different cases.

Ordinarily, in analyzing damage to a part or assembly, the following points should be observed: The repair must restore the part or assembly to a condition which is the structural equivalent of the original; it must be interchangeable and it must not require additional loose parts easily forgotten on reassembly.

Shop workers and inspectors alike find it difficult to evaluate damage. However, there are a few rules which, if adhered to, will lead to a better understand-

Figure Two (A) Typical damage to a wing skin adjacent to a riveted joint. (B) Wing skin repair consisting of a rein-forcing gusset plate laid under the skin, to which is spot weld-ed a round plug that is flush with the outer skin surface.

> ing of the problem involved. These ten laws might well be termed the "Constitution" of the salvage inspector:

- 1. The focal point of a highly stressed structure is the joining of two main assemblies
- Stresses in any assembly such as wing, empennage, landstresses in any assembly such as wing, empeninge, landing gear, nacelle, vary from a minimum at a point farthest removed to a maximum at its attachment to another assembly. (Thus, in a cantilever wing, all stresses increase from the wing tip to the fuselage joint.)

  The paths of high stress flow can be detected by the nature of riveted or screwed joints.
- 4. Changes in stress flow can be detected by the increase or decrease in rivet pitch.
- or decrease in rivet pitch.

  5. The members carrying high concentrated loads can be detected by their nature or by end fittings and attachments.

  6. All surface material exposed to the airstream is subjected to airpressure loads. (This includes "unimportant" looking engine cowling and fairing.)

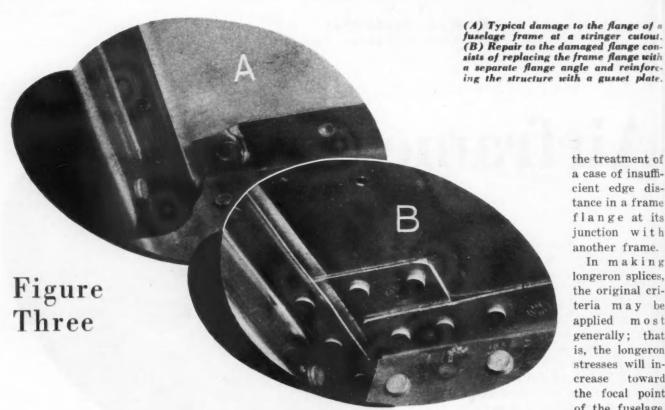
  7. Bolt izes are an indication of the loads transmitted through them and the margins are seldom excessive.

  8. Don't overestimate the strength of steel parts; they, too, have limiting strength.

- them and the margins are settled excessive.

  8. Don't overestimate the strength of steel parts; they, too, have limiting strength.

  9. Don't underestimate the importance of screw-attached cover plates; assume they are designd to carry loads.



10. Remember that the repair requires greater skill than the

#### **Sheet Metal Repairs**

Sheet metal repairs rank high in salvage operations. The first step in working out suitable repairs is to have a complete knowledge of the materials used in the assembly. It is important, for example, to determine whether the aluminum alloy sheet is alclad, bare material or in the SRT condition. The same applies to the rivets used. It must be determined whether they are A17ST, 17ST or 24ST, so that the actual repair will utilize the same materials and strength as the basic constituents. Where bare aluminum alloy material is used, it is necessary to anodize each part to assembly in order to prevent corrosion. Rivet, screw, and bolt holes should be burred with a wire brush or steel wool, yet not chamfered. When drilling holes for either rivets, screws, or bolts, it is advisable to first drill undersize and then ream to a close fit.

One of the most common forms of sheet metal difficulties is the matter of edge distance for riveted or screwed joints at the edge of a sheet. When this occurs, the potential failure is removed by adding a doubler at the edge of the sheet, lying underneath the leg of the stringer or frame connecting the edge of the original skin. This doubler should extend away from the original joint and an additional row of rivets used to transmit part of the skin loads to the doubler, thus placing the joint rivets in double shear and bearing instead of singly. Where cut countersunk rivets are used, additional allowance must be made in the standard specified edge distances to allow for the bearing failures which invariably result on the feathered edge of the sheet. Fig. 1 illustrates

the treatment of a case of insufficient edge distance in a frame flange at its junction with another frame.

In making longeron splices, the original criteria may be applied most generally; that is, the longeron stresses will intoward crease the focal point of the fuselage. Butt splices are

usually resorted to, using generous doublers and liners to transmit the load across the joint. One fact remains to be carefully observed in this type of splice. Any splice plate added to the assembly should not be joggled between the two main segments of the prime member, as joggled plates do not operate as effectively as flat sheets.

Cold reworking of any aluminum alloy sheet in the heat-treated condition must be avoided unless so directed by the salvage engineer. Internal strains and sub-surface cracks are caused by this operation which can greatly weaken the part or reduce its fatigue life. It is better to anneal the material to the SO condition before proceeding on any reforming operation.

One common form of salvage operation is the elimination of so-called "oil cans" in skin surfaces. If the original skin is found to be generally loose, it is advisable to remove the rivets from at least two sides, stretch the skin and rerivet using the next larger size rivets. Even though residual buckles appear to be severe deformations, the actual change in length due to stretching and reriveting is small. Temperature changes will accentuate the "oil can" condition and the subsequent constant local flexing will result in fatigue cracks. "Oil cans" may be eliminated by the addition of stiffeners. When this is done, several pertinent facts must be observed. Light equallegged angles may be fabricated using the same, or one gage higher material than the affected skin. These angles should be laid on as intercostals between frames or ribs. Each end of the stiffener must be attached or clipped to ribs or frames. This is necessary to avoid fatigue cracks in the adjoining skin. If it is desired to run an auxiliary stiffener through a rib or frame, the

(Turn to page 74, please)



"Flying" bulldozers and scrapers will quickly repair this bombed airfield.



"Come on—Back the Attack
—Buy War Bonds!"

### **Bulldozers That Fly**

An airfield is bombed, but within a few minutes after the "all clear" signal is given Yankee engineers are at work repairing the damage with sturdy bulldozer and scraper units that are small enough to be flown anywhere by transport plane or glider. But repairing airfields is not the only job performed by these husky units—they also help build new airfields and vital supply routes, prepare camp sites, and perform many other chores so important to Victory.

Much of the steel used in these "flying" earthmovers is furnished by Inland to the La Plant-Choate Manufacturing Co., Cedar Rapids, Iowa. Producing steel for tough construction equipment is an old assignment to Inland steelmakers and metallurgists. A large tonnage of the steel shipped for this purpose before the war was Inland Hi-Steel—the steel that builds stronger and saves weight—the steel that will again be used for peacetime machinery when released from the demands of war.



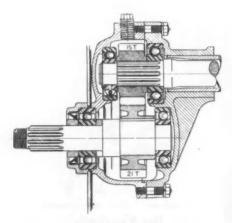
#### INLAND STEEL COMPANY

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# Military Version of the

By Philip Ruskin



Cross section of the rear axle

THE German Volkswagen or "People's Car" made its first public appearance at the Berlin Automobile Show in February, 1939, but its role as a civilian vehicle was short-lived, for six months later Europe was at war and the Volkswagen was converted to a light aid detachment car for the German Army. One of the Volkswagens manufactured in 1941 and captured in the Middle East was examined last year by the engineering staff of Humber Ltd., England, which recently issued a detailed technical report on its design and specifications. This article is based upon the analysis of the military vehicle by the Hum-

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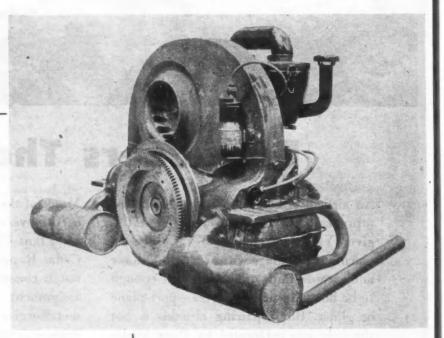
#### Volkswagen Specifications

#### Engine

Type—Overhead valve.
Cylinders—Four, horizontally opposed, air cooled.)
Bore and stroke—2.75 in. by 2.52 in.
Piston displacement—60 cu. in.
Compression ratio—5.2:1 (measured)
—5.8:1 (instruction book)

#### Dimensions

Wheelbase—94 in.
Front tread—54.625 in.
Rear tread—55.125 in.
Overall length—147.5 in.
Overall width—63 in.
Overall height—63.5 in.
Ground clearance—10 in.
Min. turning circle—RH, 30 ft. 5 in.
LH, 36 ft. 8 in.



Three-quarter rear view of the engine

#### Vehicle Weights (Lb.)

	Empty	Loaded
Front wheels	644	992
Rear wheels	1008	1598
Total	1652	2590

#### **Gear Ratios**

Ocur acutos	
Rear Axle-4-43:1 Wheel hub-1.40:1	
Speed Trans.	Overall
Fourth 0. 8:1	4.96:1
Third 1,25:1	7.75:1
Second 2.07:1	12.83:1
First 3.60:1	22.32:1
Reverse 6.60:1	40.92:1

#### Tires and Wheels

Tire size—8 x 12, airplane type. Wheel size—4.25 x 12, flat base rim. ber engineers and supplements a description of the original design published in the March 25, 1939, issue of AUTOMOTIVE INDUSTRIES.

Several modifications were made to the Volkswagen to adapt it to war use, the military version differing chiefly from the civilian car in the following respects: An open type touring body with collapsible fabric top replaced a sedan type body. New equipment included special wheels and tires,

a larger gasoline tank, and hub reduction gears added at the rear wheels to lower the overall gear ratio and also increase the ground clearance under the rear axle housing. The examined Volkswagen, which had considerable mileage run up on it, was also equipped with a special steel trunk that housed a gas welding plant for repairing military vehicles.

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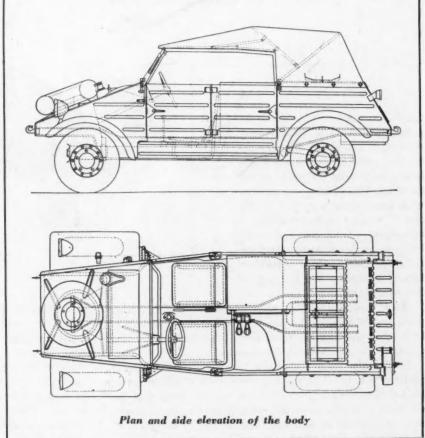
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The outstanding feature of this vehicle is the horizontally opposed 4-cylinder, air-cooled, overhead valve engine mounted in unit with the clutch, 4-speed transmission and the rear axle drive mechanism. This design was intended, presumably, to provide all-climate service and maximum tractive effort. With the power-plant located at the rear, the weight distribution (empty or loaded) is approximately 39 per cent on the front wheels and 61 per cent on the rear wheels. In 1939 the maximum output of the engine was announced as 24 hp at 3000 rpm.

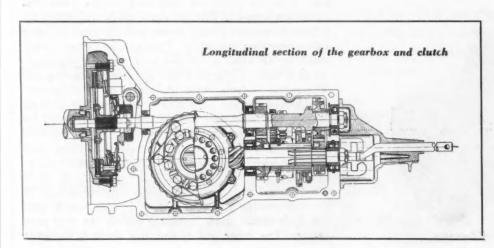
The four-throw crankshaft is supported by three main bearings and another bearing at the auxiliary drives for additional support. These bearings are of the steel shell type with lead bronze linings. It is

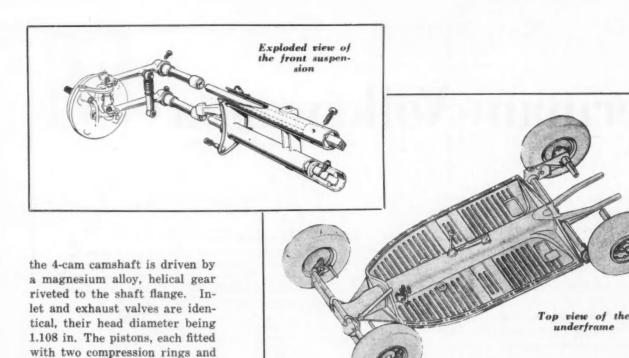
German Volkswagen



a short stroke engine, the stroke-bore ratio being 0.91 to 1 as compared to the U.S. average of 1.25 to 1. Each bank of cylinders, made of grey cast iron containing chromium and copper, and Brinelling 251, are

separately cast and interchangeable. The silicon-aluminum alloy cylinder heads, cast in pairs, have bronze alloy valve seat inserts, phosphor bronze valve guides, and steel spark plug inserts. The crankcase, an aluminum alloy casting, is built in two parts and divided on the vertical center line passing through the main bearings and camshaft bearings. Supported directly below the crankshaft by three bearings.

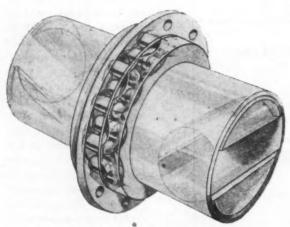




the small ends. Main, connecting rod and camshaft bearings are pressure lubricated, as are the rocker arm bearings by oil fed through the push rods. A tubular type oil cooler is incorporated in the system.

one oil scraper ring, are made of aluminum alloy. Big end bearings of the H-section connecting rods are cast babbitt. Phosphor bronze bushings are pressed in

Special attention was given to provide positive air cooling for the engine by means of a centrifugal blower which runs at 1.75 times engine speed and is enclosed in a semi-circular cowling that extends down over the cylinders and cylinder heads. The interior of the cowling is baffled so as to direct the flow of air over the cooling fins, and also through the oil cooler, which is located within the cowling. Auxiliary blades on the blower rotor draw air through the generator to cool it. The blower and generator are driven by a V-belt off the crankshaft pulley. The electrical system is 6-volt of Bosch manufacture.



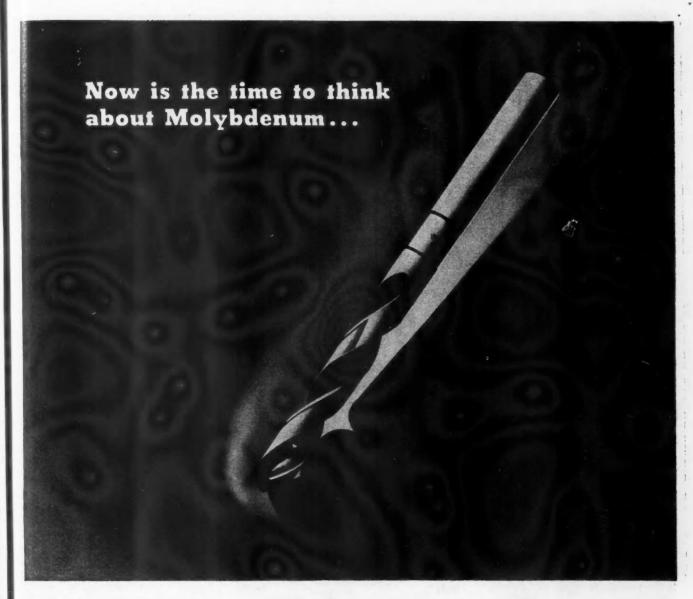
Phantom view of the differential

The Solex downdraft carburetor fitted with an oil bath air cleaner and a manifold made of tubing and incorporating a "hot spot" chamber comprise the induction system. Fuel in the civilian version was fed by gravity from the tank at the front, but in the military car the engine is equipped with a fuel pump, evidently to provide positive feed on exceptionally steep slopes. The fuel tank capacity is 111/4 gallons, about 70 per cent greater than that of the earlier tank.

underframe

The clutch, transmission and axle differential are housed in a magnesium alloy case which is divided longitudinally and vertically into two sections. These three units and the engine are mounted on rubber arranged to allow rotational movement of the combination about an axis through the engine's center of gravity and coinciding with the center line of the vehicle in plan. Although this rubber mounting is arranged to operate through the center of gravity of the engine with the object of absorbing torque reactions, its effectiveness is limited since there are other reactions from the swing of the half-axles in the rear axle suspension assembly. This can be better understood by an analysis of the rear axle arrangement. On each side of the part of the casing enclosing the differential, co-axial with the spiral bevel ring gear, is a hemi-spherical seat which provides the bearing surface for the inner end of the half-axle tube. A cap provides the anchorage and the whole joint is enclosed in a concentric, flexible sleeve. Thus, each half-axle swings freely about its hemi-spherical attachment.

A "limited slip" type differential, the outer ends of which are radially slotted with a circular hole to provide a universal joint, is located within the ring gear center. The inner end of the axle shaft is flattened th



With both molybdenum and tungsten again available for use in high speed steel, consideration of their comparative performance is timely.

Before the war, a careful recording of comparative tests converted many users and tool makers to molybdenum high speed steel. During the tungsten shortage, when use of a high percentage of molybdenum types became mandatory, most users could not watch the performance of their tools carefully enough to draw conclusions on their respective merits.

Reports from large tool producers and users confirm that molybdenum high speed steels, when properly heat treated, perform at least as well under different kinds of shop conditions as the tungsten types which they replace.

Given equal performance on any particular type of work, an investigation of the saving in machining cost effected by molybdenum steels will prove well worth while.

CLIMAX FURNISHES AUTHORITATIVE ENGINEERING DATA ON MOLYBDENUM APPLICATIONS.



MOLYBDIC OXIDE, BRIQUETTED OR CANNED .
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April 15, 1944

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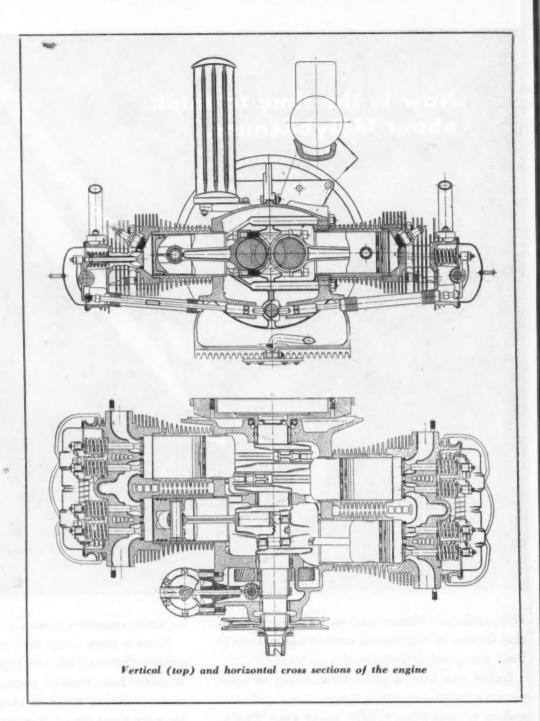
39

and drops into the aforementioned slot. On each side of the shaft "flat" there is a half - cylindrical segment which forms the other part of the universal joint. Differential action with a slip up to 12.5 per cent is obtained by means of spherical - ended plungers that automatically mate with mating slots in rings which, in turn, are attached to each of the two universal joints.

An unusual innovation to be found at the outer extremity of each halfaxle is a casing which combines the junctions of the rear wheel hub bracket, a brake back plate and the housing for spur type reduction gears. The purpose of the spur gears is to provide extra low gearing and to increase ground clearance.

The transmission is the two-shaft type with four forward and one reverse speeds. The sliding gear type engagement is provided for first, second and reverse speeds, the gears being the spurtype. Two trains of helical gears are

constantly in mesh and provide the third and fourth speeds alternatively. There are no synchronizing arrangements but there is an ingenious gear-engaging system which facilitates gear meshing. A series of nine pins fit into semi-circular grooves in a sleeve splined onto the shaft and also into semi-circular grooves in the first and second gear clusters. These pins transmit the drive to the cluster which gives either first or second speed when these are meshed in the ordinary way. But to obtain third or fourth speed, the pins are moved along the grooves by the selector and their ends engage with corresponding holes in one of the constant mesh gears. By this means, the normal dog engagement gear is replaced



and the overall length of the gear box is shortened.

The frame is constructed of a distinctive, ribbed, pressed-steel platform with a semi-tubular backbone. It is arranged at the front to carry the torsion bar tubes and, at the rear, forked to form a cradle for the powerplant. The floor of the frame is approximately 0.05 in. thick while the backbone section is 0.10 in. thick.

The front wheel suspension is independent and employs torsion bars for connection to the chassis similar to the rear wheels. However, the arrangement is necessarily different. The stub axle swivel on each side is carried by a pair of trailing parallel motion (Turn to page 72, please)



## LONG STANDING, LEAK-PROOF UNIONS DISASSEMBLE READILY!

The lubricating, non-hardening properties of Permatex Pipe Joint Cement permit easy readjustment of pipe lines . . . without thread

Permatex Pipe Joint Cement is a heavy, brushable, ready-to-use product. It flows easily from the brush, spreads evenly over the threads and "stays put".

The applied film is leak-proof to hot and cold water, steam, salt water, illuminating cold water, steam, salt water, illuminating ags, lubricating oils, gasoline, gasoline, yapor, kerosene, ethylene glycol and yapor, kerosene, ethylene glycol and numerous other liquids and gases, numerous other liquids and gases.

Permatex Pipe Joint Cement is used wherever pressure-tight, leak-proof unions are required.

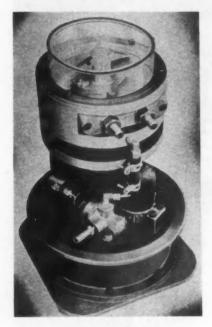
PERMATEX COMPANY, INC. Sheepshead Bay, N. Y., U. S. A.

PERMATEX

## New Production Equipment

THE DYNATROL, a device for the highspeed, arcless current interruption of inductive d-c circuits, has been brought out by Sciaky Bros., Chicago, Ill. The dynatrol is designed to replace magnetic contactors formerly used on resistance welders of the electro-magnetic, stored-energy type.

The dynatrol interrupts the charging current without arc. It is essentially a



Sciaky Dynatrol

high-speed, single-pole interrupter, the contact points of which are shunted by a bank of capacitors. The movable contacts open with a very high acceleration, so that at any instant they have separated sufficiently to prevent a discharge while the primary current is directed to the capacitors.

The dynatrol is available on all Sciaky stored-energy welders up to and including 50 kw.

JESSOP STEEL COMPANY, Washington, Pa., announces Malta carbide tipped tools, a line of cemented carbides for cutting steel, cast iron, non-ferrous and non-metallic materials.

Jessop Malta carbide tipped tools are manufactured in ten different styles in a wide range of sizes and three grades of tips, MF for miscellaneous finishing, SF for steel finishing and CR for coarse roughing. The three grades are distinguished by colored shank ends:

MF—red, SF—white, and CR—blue, to insure proper grade selection. The tools are rust proofed to permit long storage safely.

D ESIGNED and built by Buffalo Forge Company, Buffalo, N. Y., the No. 17 billet shear, which weighs over 80 tons, is believed to be the largest machine of its type ever constructed.

Every part of this machine is on a huge scale. Pressure on the knives is 4,500,000 lb., making light work of cutting 10-in. steel bars at the rate of six cuts per minute. Clutch and hold-down are air operated, and automatic pressure lubrication is provided by a lubricator mounted on the machine.

The whole unit is operated by a 125 hp motor which drives the flywheel through multiple V-belts.

S NYDER TOOL AND ENGINEERING COM-PANY, Detroit, Mich., has designed and built a special-purpose, 3-way hydraulically operated machine for keyseating and milling valve rocker covers for aircraft engines.

The operating mechanisms are mounted on main slides, which, when placed in rear position, allow room for indexing. After indexing, all three units are moved forward and into working position by means of individual hydraulic cylinders.

Keyseating tools are actuated through a crank mechanism and are fed up and down by hydraulic cylinders through a feed cam. The crank mechanism is motor driven through V-belts and pulleys, and a worm and worm wheel. The V-belt pulleys allow for some variation

in the number of strokes per minute made by the keyseating tools.

The slotting tools start their shaper motion and are fed into the work on each of the two side units while, on the rear unit, cutters start to rotate and feed into the work, cutting a clearance pocket for the second slotting tool.

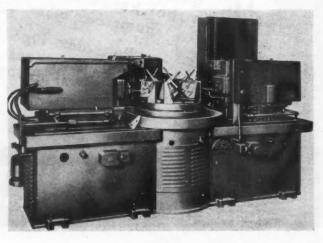
The milling spindles are ball-bearing mounted and worm wheel driven. The double spindle housing slide is moved up and down a very short distance for the depth of cut, therefore, a plain V-belt drive from motor to worm shaft is adequate.

This machine is unique in that cutting of the clearances and slotting the two keyways is performed in sequence with but one handling of the parts. There is no time lag, and the operator is continuously busy loading and unloading while the machine is doing the

Two new Stellite tipped tools, especially designed for machining steel, are offered by Haynes Stellite Company, Kokomo, Ind. The new tools, designated as Style P and Style Q, consist of a cutting tip of Stellite 98M2 cobalt-base alloy brazed or butt-welded to a tough steel shank, with proper clearance and lead angles ground for turning steel. These and other Stellite tipped tools are recommended by the manufacturer for applications employing tools that have a large cross section or tools that are bent or offset, or for tool holders which make the use of solid tool bits impractical. In addition to in turning, boring, and facing 1180 operations, these tipped tools are also

(Turn to page 80, please)

Snyder 3-way hydraulically operated machine for keyseating and milling valve rocker covers





## DOW ANNOUNCES another important price reduction in

# STYNON

(DOW POLYSTYRENE)

In a move of far-reaching significance to the entire plastic industry, Dow announces a reduction in the base price of Styron (Dow Polystyrene)—from 30 to 27 cents per pound. The new low price, at which you may now obtain this strategic plastic from its source, is made possible by improved and vastly increased production.

Current rubber needs for styrene—chemical antecedent of polystyrene—are, of course, of major importance today. But, Dow's ability to lower the price of polystyrene places this plastic in a price range favorable to greatly extended uses for which this outstanding thermoplastic material has proved peculiarly adaptable. It will undoubtedly affect the design and manufacture of literally thousands of products now and when Peace returns.

Complete Styron price lists are available on request.

THE DOW CHEMICAL COMPANY, MIDLAND, MICHIGAN
New York · Boston · Philadelphia · Washington · Cleveland · Detroit · Chicago · St. Louis · Houston · San Francisco · Los Angeles · Seattle

DOW STYRON . . for fabricators producing moldings, extrusions, red, sheet.

PLASTICS ETHOCEL... for fabricators producing moldings, extrusions, coatings; available also as Ethocel Sheeting.

INCLUDE SARAN... for fabricators producing moldings, extrusions, pipe, tubing, sheet; available also as Saran Film.

Write for New Dow Booklet "A Practical Approach to Plastics."

STYRON

(DOW POLYSTYRENE)



# Airbriefs By Henry Lowe Brownback

#### Originality

This is rare quality in that it takes genius and courage. We Americans have it in a large degree and this is shown best in our manufacturing processes. Here we lead the world, especially when we are faced with the problem of getting out huge quantities of intricate machinery to precision tolerances in mass production. Our designs, however, are not so original. I remember that in 1926 or '27 when, returning from Europe, I was struck by the fact that most cars were trying to look like the LaSalle which was the season's "hit" and later by the universal adoption of the nose scheme of the Lincoln Zephyr and in 1942 that of Cadillac. Engineering departments are not to blame for this, but it comes from a desire on the parts of sales to cash in on a current favorite's popularity. may be good business for a time, but it kills initiative and, later on, sales, as all of the product becomes so much alike that price is the governing factor. I must say that a great number of different machines all as much "not alike" as possible appeals to me as not only conducive to progress in design, but also in the satisfaction of owning "something different."

Desirable as this making of something original is in an industry which is stabilized to a large extent, it is vital to the progress of an infant industry like aircraft. Notice the British who usually do not show the marked degree of difference in design as the Continentals. No one would ever confuse any one of their military aircraft with any other and their three principal engines are as different as human imagination can make them. On the other hand, many of our aircraft are so much alike that it about takes an expert to tell them apart and nearly all of our radial engines, big and little, have a strong family resemblance although the mechanical details are different.

In the making of our small aircraft we have followed a pattern in which most of the planes are much alike and the engines are certainly close cousins. This is not healthy, as not enough progress has been made in either planes or engines to indicate the mold in which they should be cast. The "X" company brings out a high-wing monoplane with

a four-cylinder opposed engine and sells a thousand of them, so four or five other companies put out a similar plane and it all boils down to price. My plea is to keep up making improvements and to keep different designs to the front until we know a lot more than we do now. Our aircraft and our aircraft engines, big and little, are magnificent but we are still in the formative period and all of our planes and engines can and must be improved before we get real mass production possibilities for peacetime.

#### Sleeve Valves

Years ago an American, Charles Y. Knight, worked out the first successful sleeve valve internal combustion engine and had to go abroad, just as the Wright Brothers did, to get it going. The "Silent Knight" engine started a whole landslide of non-poppet valve engines, which like itself have disappeared. The sole survivor is the Argyll engine with oscillating - reciprocating single sleeve. This type of engine was adapted to an air-cooled radial aircraft design by Bristol in England, replacing it with their world famous "Jupiter." This engine has been so successful that the British have now changed their largest liquid-cooled engine to this type of valves and they are using them in their best-known auxiliary engine. The sleeve or piston valve has certain advantages which are worth studying and working out and the fact that they are being used so widely in Britain is proof that they are more than just something "different.'

#### Aluminum Cooling Jackets

A few weeks ago I was asked by an engine manufacturer if I knew anything about the application of aluminum finned jackets or covering to steel liners. He had heard that one American manufacturer was using them. This is true—the Ranger engine is using a steel sleeve to which is bonded a finned aluminum shell. Details of this new

process (Al-Fin) are given in the March 15th issue (page 148) of AUTO-MOTIVE AND AVIATION INDUSTRIES. The French Salmson engine has used an aluminum cylinder, to which a finned aluminum shell is bonded ever since they have built air-cooled radial engines starting in the early 1920's, and they have had perfect success with it. It is significant that Ranger has had at least one very noted French engineer on its research staff for about two years and, knowing him well, I look for some other developments of note.

#### Aluminum Again

Every once in a while a paragraph in Airbriefs brings an unusually large number of inquiries and the one on brazing aluminum has certainly done that. I have received a very fine booklet published by the Aluminum Company of America on the "Welding and Brazing of Aluminum" which should help many people in the aircraft industry if my mail is any criterion. I have also had many letters on bearing metals asking for references on experiments. The experiments on gold, silver, copper, aluminum and others, of which I wrote, were made by myself in France, both on test machines and on some high speed engines, in several cases against guided and unguided rollers and needles.

#### Rockets

The new guided winged German rockets which look like giant gulls have done much damage and it looks as though rockets in general are going to revolutionize artillery. At the beginning of the war the supercharges then in vogue sufficed, but were soon outmoded by high altitude "flak." put a lot of planes and engines on the salvage" list. Higher altitude planes then made even the highest velocity shells a gamble, as the shell takes from 7 to 14 seconds to reach the flying altitudes of the planes, but rockets can go higher than any plane, and guided rockets can not only follow the target, but can contain devices to explode them at will, thus making this type of antiaircraft artillery most dangerous.

#### Electric Drives

I have had several letters asking how fast the gas turbines run and how propellers would be driven by them. It is my belief that planes large enough to be driven by large gas turbines will use high speed machines and electric drives such as those used in many American ships and the French Normandie, whose engines were of American design.



April 15, 1944

RIES

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45

#### Strike Situation Under Better Control in and around Detroit

Few Strikes in Michigan Since Union Took Action to End Unauthorized Strikes and Enforce Its No Strike Pledge

Only five strikes, all of short duration, occurred in the Detroit area in the three weeks following the recent disciplinary action by the UAW-CIO against 121 wildcat strikers involved in a disturbance at the Ford Rouge aircraft engine building. The discharge of 26 men and the laying off of 48 others apparently had its sobering effect as the union took its first drastic action to end the epidemic of unauthorized strikes in Michigan and to enforce its no-strike pledge. This decrease in strikes compared with 64 strikes in Michigan during February, the highest number for any month since Pearl Har-Strikes in February involved workers. The 64 February 42,640 workers. strikes compared with 36 in January and 56 in December, the previous peak for any war-time month. In the two years ending last Dec. 31, there were 423 strikes in Detroit plants involving 295,000 workers. This was an average of one strike every two and one-third days. These strikes averaged 697 workers, lasted an average of 31/2 days and involved an average loss of 2,416 man-

A factional fight within Ford Local 600, which with a claimed 80,000 members is the largest union local in the country, followed the crack down on the aircraft engine building strikers. A dissident group of 1,500 employes in the aircraft engine unit booed inter-national and local union officers at a union meeting and demanded that the UAW-CIO rescind its no-strike pledge. They also requested that a strike vote be taken and that the government take over operation of the Ford Rouge plant. A spokesman for this group said they were rebelling against Ford's anti-labor personnel dept. and asserted that production would increase from 15 to 30 per cent if the government took over the plant. However, the international officers' disciplinary action was approved by seven representatives of 5,000 workers in the "B" Building at the Rouge plant. But 250 employes in the production foundry staged a one-day walkout in protest over the firing of six men for failing to meet quotas.

Meanwhile, 2,000 members of Briggs Local 212 of the UAW-CIO voted to petition the international union to rescind its war-time no-strike pledge. "Labor is simply fed up with taking the back seat and the only way we can enforce our rights is to get our strike privilege back," said the local president. Briggs Mfg. Co. plants in De-troit have been affected by several strikes recently. Thirty-seven hundred workers at the Biggs Outer Drive plant, which manufactures airplane ball turrets, were idle for most of two days due to a strike by 80 tool crib opera-The latter were protesting a WLB decision in January denying them a wage increase. Earlier, a one-day strike occurred in the Mack Avenue plant, making tank hulls, when 71 electric truck and crane operators walked out after being turned down by the WLB on a wage raise. This made 400 idle. The union local plans to take an informal strike vote over delay in negotiating a new contract. The previous contract expired Nov. 13, 1943, but it was ordered continued in effect by the

(Turn to page 52, please)

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#### **Ultimate Course of Steel Prices** Will Depend on Decisions of WLB

Price Adjustments Are Considered Stop-Gap Measures Until Action Is Taken on Demands of Unions for Wage Increases

By W. C. Hirsch

Steel consumers, and especially so peace-time automobile manufacturers, are following closely Washington developments with reference to the adjustment of ceiling prices asked by producers on the basis of higher costs. It is possible that, by the time this is published, minor revisions of the price structure may already have been sanctioned by OPA, but it is generally recognized in the steel market that the ultimate course of prices will be determined when the War Labor Board passes on the demand for a 17 cents an hour increase in wages of the steel workers' unions. Until then, price adjustments are looked upon as stop-gap measures. It is understood, however, that steel producers have submitted to OPA exhaustive reports on prevailing costs, and that these have been subjected to careful analysis. Some of the Washington officials are reluctant, it is reported, to lift ceiling prices of any product of a company that makes a satisfactory profit showing for its business as a whole. Steel producers say they would not be able to show any over-all profits, did they not segregate the cost of each product and strive to make it self-supporting. Permission has been granted by OPA for adjustable pricing agreements in iron ore sales while the agency completes a study of the industry's contention that prevailing ceilings "are not generally

fair and equitable." Felt rather painfully by motor truck war contractors for some time, the bottleneck in the delivery of gray iron castings now promises to come in for closer attention. Spokesmen for the gray iron foundrymen point to the absence of an adequate price policy, as the chief cause of dwindling production. that OPA considers 4 per cent as a fair profit for gray iron foundries while their own cost accountants consider 10 per cent as "absolute mimimum." The plaint of the gray iron foundrymen is typical of the mounting difficulties with which OPA has to contend. It is beginning to be better understood in Washington that deflation of steel prices resulting from failure to make realistic adjustments in good time and coming when reconversion is under serious consideration, might prove as dangerous as inflation. Stabilization can be attained only through avoiding both inflation and

Forgings, which are under the scheduling jurisdiction of the War Production Board's Aluminum and Magnesium Division, have been classified as undesignated products under the terms of General Scheduling Order These products include propellers, crank cases, pistons, large hammer forgings (10,000 pounds and over), small hammer forgings (less than 10,000 pounds) and press forgings. Use the
Stainless Strip
that SIMPLIFIES
Production
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PRODUCED ON AUTOMATICS—Notwithstanding the high tensile strength required in this material, its high ductility makes possible complete fabrication on special automatic machines.



REVERSE DRAWS NO PROBLEM—Uniform Carpenter Stainless Strip made possible this difficult reverse drawn part. Danger of splitting around the edge of the inside hole was entirely eliminated.



PROOF OF DEEP DRAWING QUALITIES—Here's an example of the way in which Carpenter Stainless Strip can be deep drawn. Easy working qualities, plus the close tolerances to which the strip is held, affect savings in deep drawing costs.

When you choose a Stainless Strip today, you want one that blanks and forms readily, keeps output at a high level, and is easy on your tools and dies.

Carpenter Stainless Strip gives you that kind of performance. This Strip blanks as clean as a whistle, yet has ample ductility for fast, easy forming. And Carpenter Stainless Strip works the same, coil after coil, as a result of uniform temper.

In thousands of press rooms, ductile, bright-finish Carpenter Stainless Strip is smoothing out wartime production difficulties. And some of the same manufacturers who are side-stepping fabrication troubles with this Stainless Strip today, are planning on it to get greater Stainless production economy in their post-war products.

Investigate Carpenter Stainless Steel now! Get in touch with any of the Carpenter offices below, and put your problem up to your Carpenter representative. He will help you make your Stainless operations more economically productive now and in the future.



This handy Carpenter Stainless Steel Selector Slide Chart will help you quickly spot the right grade of Stainless to meet your requirements. It provides data on working properties, physical characteristics, etc., of each grade of Stainless. A note on your company letterhead will bring you a Slide Chart...free to Stainless users in the U.S.A.



#### **March Production of Aircraft Exceeds All Former Records**

May be Peak of the War in the Number of Planes Produced, According to C. E. Wilson, Chairman of APB

General Motors Corp. delivered war materials valued at \$3,546,684,598 in 1943, a gain of 87 per cent over 1942 war shipments of \$1,898,195,445, it was announced by A. P. Sloan, Jr., board chairman, in the corporation's annual report. The 1943 deliveries were almost nine times greater than war product shipments in 1941, mostly prior to Pearl Harbor, which totaled \$406,149,-273. GM war deliveries in 1943 comprised 41 per cent of the automotive industry's total armament shipments for the year, which have been estimated at \$8,676,000,000 by the ACWP. War products represented approximately 93 per cent of GM net sales of \$3,796, 115,000 last year.

Aircraft items now account for more than 40 per cent of the dollar volume of GM war production, according to the report. The corporation's war contracts cover more than 2,300 separate items, ranging from minute ball bearings made by New Departure to 30-ton tanks turned out by Fisher Body. Production totals range up to seven figures. The Inland Mfg. Division at Dayton, Ohio, recently manufactured its 1,000,000th .30-caliber carbine rifle only 19 months after the final drawings were released. AC Spark Plug Division at Flint assembled 10,000 intricate T-1 bombsights in 17 months. And the Allison Division at Indianapolis recently celebrated the production of its 50,000th aircraft engine. GM is operating 99 of its own plants in the U.S. totaling 77,000,000 sq. ft. of floor area and in addition 16 government-owned plants containing 12,000,000 sq. ft. These plants contain 130,000 machine tools, of which 69,000, or 53 per cent, belong to GM. GM has 17,000 machine tools, for which no war-time use could be found, in storage.

Chrysler Corp. shipments of war material for 1943 totaled \$847,712,504, according to the annual report. This marked an increase of 55 per cent over 1942 war deliveries of \$547,995,312. Ninety-six per cent of 1943 net sales of \$886,467,702 was war products. Studebaker Corp. net sales for 1943 hit an all-time high, reaching \$364,191,211, an advance of 64 per cent over the previous year. Packard Motor Car Co. war shipments of aircraft and marine engines totaled \$339,896,604 in 1943, a gain of 58 per cent over 1942 war product deliveries of \$214,146,817. Volume

(Turn to page 58, please)



A properly designed Live Center is one of the fundamentals of setting up a job and requires a specialist's experience. Characteristic of the design of all STURDIMATIC LIVE CENTERS is a low overhang and a slight cushioning action that compensates for expansion due to heat shock and excessive thrust loads—reducing wear to a minimum. Send us your blueprints and specifications—we will see that your job gets set up with the right Live Center. Standard shanks with Morse taper carried in stock.

## STURDIMATIC

TOOL COMPANY 5226 THIRD AVE., DETROIT, MICHIGAN

LIVE CENTERS

#### 1943 Truck Tractor and Truck Production

(U. S. plants only)

Supplementing those data of "Production of Truck and Truck Tractors" found on page 92 of the March 15, 1944 issue of AUTOMOTIVE AND AVIATION IN-DUSTRIES, production for the full year of 1943 amounted to 675,502 as compared with 797,195 for 1942 and 1,042,-270 during 1941. A breakdown of 1943 production by months and by weight classifications, with a few revisions to those data published previously fol-

2011				
1943	Light	Medium	Heavy	Total
Jan	23,727	7,019	18,639	49,385
Feb	23,314	6,453	17,553	47,320
March	27,544	8,268	20,065	55,877
April	23,107	9,717	23,273	56,097
May	21,217	12,696	21,244	55,157
June	20,734	14,070	21,658	56,462
July	20,925	16,024	23,321	60,270
Aug	19,944	17,809	23,520	61,273
Sept	21,089	16,094	20,254	57,437
Oct	22,046	17,807	20,145	59,998
Nov	21,717	15,120	20,132	56,969
Dec	23,074	13,910	22,273	59,257



#### A TRIBUTE TO THE BATH IRON WORKS

### from the makers of PENNSALT CLEANERS

• The first ship built in America, the "Virginia,"

was launched from the shores of the Kennebec in 1607. The Bath Iron Works Corporation is carrying on the tradition of the Kennebec today, launching destroyers like the one above. At its present rate of production, B.I.W. produces in one year more than twice as many of these ships as were launched by them during the entire World War I. Our hats are off to the men and women who have made possible this enviable record.

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Total

19,385

17,320 55,877 56,097

55,157 56,462

60,270 61,273 57,437 59,998

TRIES

How fine these ships are is well expressed in the following extract from a letter written by the commanding officer of the destroyer pictured above:

"A word of praise for the grand job the Bath Iron Works did on the ship. She has been through h—l and high water and never failed us. Keep on building ships as fine as this . . . We have put on nearly one

hundred and fifty thousand miles and she is as good as new."

We of Penn Salt are proud of the small part we are privileged to play in this outstanding achievement.

Galvanized work on these ships is first cleaned with a Pennsalt Cleaner to insure a finish which will withstand the extreme corrosive conditions of the sea.

Paint stripping is another important use of Pennsalt Cleaners at the B.I.W. In fact there is a Pennsalt Cleaner scientifically designed for nearly every type of metal and maintenance cleaning.

Our chemical engineers will be glad to demonstrate the benefits of Pennsalt Cleaners to you in your plant. No obligation. Write fully to our Special Chemicals Division, Dept. AA

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#### Obituary

Joseph T. Schlacks, 74, one-time vicepresident of McCord Radiator & Mfg. Co., died March 16 at his home in Detroit. He retired from his position with McCord in 1921.

Otto A. Lindstrom, 60, superintendent in the tool and die shop at Ford Motor Co., died March 24 at his home in Detroit. He had been with Ford since 1914. He also had served recently as a consultant to the WPB.

Richard E. Baus, 66, former production manager and purchasing agent for the Studebaker Corp., died March 26 at Miami, Fla. He joined Studebaker in 1907 at Detroit. Later he invented a double decking device for transporting automobiles.

Jules S. Bache, 82, vice-president and a director of Chrysler Corp., died March 24 at his winter home in Palm Beach, Fla., after a short illness. He was a partner in J. S. Bache & Co., New York investment bankers, and a director of Motor Products Corp.

Louis A. Howe, 71, for 12 years manager of the Nankin Mills (Mich.) plant of the Ford Motor Co., died March 29 at his home at Detroit. He had been with Ford since 1910.



#### Awards

Names and winners of Army-Navy "E" awards in or allied with the automotive awards in or allied with the automotive and aviation industries, announced since the April 1 issue of Automotive and Aviation Industries went to press:
THE BEAD CHAIN MANUFACTURING COMPANY, Milwaukee, Wis.
THE BUDA COMPANY, Harvey, Ill. FAFNIR BEARING COMPANY, Holland Division, Holland, Mich.
FIRESTONE TIRE & RUBBER COMPANY, Nebraska Ordanace Corporation.

PANY, Nebraska Ordnance Corporation, Nebraska Ordnance Plant, Fremont, Neb.

RADIO CORPORATION OF AMERICA, RCA Victor Division, Lancaster, Pa. SPICER MANUFACTURING COMPANY, Hillsdale Steel Products, Hillsdale, Mich. SUPERIOR TUBE COMPANY, Norristown, Pa.

WORTHINGTON PUMP AND MACHIN-ERY CORPORATION, Worthington-Gamon Meter Company, Newark, N. J.

#### "E" Star Awards

for continued meritorious services on the production front have been awarded to the following firms:
AERONCA AIRCRAFT CORPORATION,

Middletown, Ohio.
IRCRAFT ACCESSORIES CORPORA-

AIRCRAFT TION, Power Controls Division, Burbank, Cal.

DIVINE BROTHERS COMPANY, Utica,

N. Y.
THE HEIL COMPANY, Milwaukee, Wis.
HELLER BROTHERS COMPANY, Newcomerstown, Ohio.

#### Moore Receives Ordnance **Department Citation**

Clarence W. Moore, chief engineer of the Mitchell Division, United Specialties Co., was recently awarded the U. S. Ordnance Dept. citation for his work in the development of a new design of pressed steel plug on a grenade projector. As a result of Moore's work, says the official report, a great improvement in the quality of the projector was obtained, as well as a saving of 90,000 pounds of steel and 7000 machine hours in the manufacture of a million projectors. Mr. Moore originated many of the mechanical improvements included in the design recently adopted for special rifle grenades by the Army.

#### Errata

On page 54 of the April 1, 1944, issue of AUTOMOTIVE AND AVIATION INDUS-TRIES the illustrations of the Besly No. 926 grinder and the Cross special milling machine inadvertently became transposed. The one designated as the Cross milling machine should be designated as the Besly No. 926 grinder and likewise the one shown as the Besly should be designated as the Cross special milling machine.



### WATCHDOGS OF THE OIL LINES



A modulating control device, responsive to both pressure and temperature. Protects oil cooler from damage by high pressure surges in lubricating systems, and controls oil temperatures.

This FIGHTER-PILOT is far too busy with cross hairs, trigger buttons and suchlike to worry about oil cooler back-pressure surges. He has other work to do, and depends on Fulton Sylphon to protect his oil lines.

By holding circulating engine oil temperatures and pressures within narrow limits, a compound Fulton Sylphon Control Device "flattens out" the oil viscosity curve, automatically maintaining correct motor lubrication, even under most exacting conditions.

Since 1904 thousands of Fulton Sylphon Con-

trolling Devices have served long and faithfully, on hundreds of different applications, in war and peace ...doing jobs automatically that would otherwise require constant human supervision.

Why not investigate the myriad possibilities of these widely accepted bellows assemblies as applied to your own product . . . Fulton Engineers will help you. Fulton Sylphon manufacturing facilities offer many definite economies, and assure continuously dependable performance. Bulletin HB-822 gives complete information.

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SYLPHON

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SINCE 1904

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Canadian Representatives, Darling Bros., Montreal

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51

#### **Strike Situation**

(Continued from page 46)

WLB, including the maintenance of membership clause, pending a decision on 14 points at issue in the negotiations.

Expeditious handling of 15 strike leaders who led a wildcat strike at the Pontiac Motor Division of General Motors was evident when eight employes were fired and seven others given disciplinary layoffs of 30 or 60 days. The men instigated a one-shift strike of 700 employes making Diesel engine parts in protest over a 30-day layoff meted out

to a worker who led a previous brief work stoppage.

A dispute that has been in progress for more than two years between the UAW-CIO and Republic Aircraft Products Division of Aviation Corp. over wage rates resulted in two short strikes within a week at Detroit. The dispute began when the management charged that a piecework pay plan permitted an exorbitant average hourly rate of \$1.80 and some unskilled workers on highly repetitive jobs were able to earn as high as \$2.25 per hour. The dispute was finally arbitrated by Dr. Harry Shulman, umpire under the Ford-UAW-CIO contract, and an agreement

was reached on the wage issue. Under this agreement, approved by the Detroit Regional WLB, hourly rates were cut 20 to 30 cents below the average under the incentive plan but would average 10 cents above maximum going wage brackets for comparable jobs. The new rates averaged 85 cents to \$1.65 per hour. The two strikes of 1,200 workers occurred in a dispute over new time standards, the union asserting that the company expected as much work for \$1.40 per hour as it previously received for \$2.50 per hour. The WLB ordered the strikers to return to work and negotiate an agreement within 10 days to settle their differences.

### SEEING is BELIEVING

• Precision Springs cannot be manufactured without the help of modern precision equipment like the "Shadow-graph" below. This busy instrument in Accurate's inspection department helps Accurate engineers rigidly control spring quality. It is an example of the modern methods and practices which Accurate finds is necessary to maintain the high standards of Accurate quality and service... the standards you want in your spring source of supply.

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#### **Business in Brief**

Written by the Guaranty Trust Co., New York, Exclusively for Auto-MOTIVE AND AVIATION INDUSTRIES

Moderately fluctuating levels of general business activity are indicated. The seasonally adjusted index of *The New York Times* for the week ended March 25 stood at 143.2, two fractional points below the figure for the preceding week, as against 138.2 a year ago.

The upswing of pre-Easter retail trade broadened during the week ended March 25. Department store sales, as reported by the Federal Reserve Board, increased from 160 to 167 per cent of the 1935-39 average; and the values recorded were 17 per cent above the corresponding figure in 1943. Sales in 1944 to date are 2 per cent greater than the total a year earlier.

Railway freight loadings during the week ended March 25 totaled 778,925 cars, 1.0 per cent fewer than the preceding weekly number and 1.1 per cent below the comparable figure in 1942.

Production of electric power during the same period rose, contrary to the usual seasonal trend; and the total was 12.2 per cent above the output a year ago, as against a similar excess of 11.5 per cent shown a week earlier.

Crude oil production in the week ended March 25 averaged 4,384,750 barrels daily, 525 barrels below the figure for the preceding week but 16,450 barrels more than the average recommended by the Petroleum Administration for War.

Production of soft coal during the week ended March 18 was estimated at 11,920,000 net tons, 2.4 per cent below the preceding weekly figure; but for 1944 to date, output is 3.7 per cent greater than the comparable total a year earlier.

Engineering construction contracts awarded during the week ended March 23 totaled \$32,909,000, as against \$29,-415,000 for the week before, according to Engineering News-Record. Contracts so far reported in 1944 show a decline of 50 per cent from the corresponding amount in 1943, although private projects register an increase of 7 per cent.

Member bank reserves declined \$352,000,000 during the week ended March 29, and excess reserves dropped \$300,000,000 to an estimated total of \$600,000,000. Business loans of reporting members declined \$65,000,000 in the same period but stood \$393,000,000 above the total a year earlier.

# Through Piston Rings Through Piston Rings McQUAY-NORRIS ALTINIZED

PISTONS...PINS...
HARDENED AND GROUND PARTS

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McQuay-Norris is definitely air-minded. We are now suppliers of precision parts to the world's largest makers of aircraft motors. Our 34 years' experience in precision manufacture enables us to meet every demand of modern aviation for sturdy, unfailing precision parts. Your inquiries are invited.



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Piston Rings for Air
Compressor

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Machined Aluminum Pistons
Piston Rings
Hardened and Ground Parts

#### PRECISION WORKERS IN IRON, STEEL, ALUMINUM, BRONZE, MAGNESIUM



#### **PUBLICATIONS**

A new 36-page manual on Cherry Blind Rivets, No. B-44, has been issued by Cherry Rivet Co. It is illustrated with color sketches, diagrams and tabular material and covers the following general headings: description of the blind rivet, drilling of the hole, selecting the rivet and pulling head, operation, installation procedure, tools and inspection technique.\*

A folding chart illustrating the Carpenter method of identifying stainless steels has been issued by The Carpenter Steel Co. It lists the various grades, tabulates the recommended identification tests and shows the operations graphically by chart. Of

interest to chemists, metallurgists and inspectors.

New Departure Div., General Motors Corp., has issued a booklet called Making Them Round. By means of illustrations and clear, simple text, the subject has been made plain and interesting.\*

Soluble Cutting Oil At Its Best is the title a 20-page booklet issued by D. A. Stuart Oil Co. It discusses typical problems involved in the selection and application of water-mix oils. The booklet is well illustrated with photographs of machining op-erations and laboratory tests.\*

erations and laboratory tests.\*

Haines Gauge Co. has published a bulletin featuring a wide variety of made-to-specification precision gages, plug, ring, snap, flush pin, profile, etc., and includes a pictorial tour of the company's plant.\*

A new 25-page booklet by Westinghouse Electric & Mfg. Co. contains a timesaving

guide to the selection and specification of indoor and outdoor transformer installa-tions, including coordinated disconnect and protective equipment. Standard arrangements are suggested to fit the various types of distribution systems.\*

Bulletin No. 150 describing Barnesdril

standard hydraulic units for special appli-cations has been issued by the Barnes Drill Co. This bulletin covers the use of hydraulic units arranged vertically, angularly, or horizontally for special drilling, reaming, facing and boring or tapping operations in the form of special machines.\*

the form of special machines.\*

The January-February issue of The Bearing Engineer, published by the Torrington Company, contains an interesting article on needle bearings in the Vought Corsair. Another article in this same issue is Spindle Bearings for Tube Spinners.\*

The following new booklets have been issued by General Electric Company. GET-172 Aircraft Landing-Gear-and Flan-Posi-

1172, Aircraft Landing-Gear-and Flap-Position Indicating Equipment; GET-1215, RPM Aircraft Electric Tachometer: GET-1185, Aircraft Liquid-Level-Indicating Equip-ment, and the first series of a new kind of parts publication, covering 2½ inch d-c and r-f ammeters and voltmeters of the new internal-pivot design for both radio and aircraft.\*

Synchro-Start Products, Inc., has published a new booklet on Synchro-Start automatic controls. The first section of the booklet is devoted to a pictorial section designed for the purpose of acquainting the signed for the purpose of acquainting the reader with its organization and activities. The second section is made up of technical bulletins illustrating and describing its standard automatic and semi-automatic engine controls. Included, also, are specifications and price lists.\*

Solvanno Inc. has insued actalor, 4215.

Schramm, Inc., has issued catalog 4215, illustrating in complete detail its No. 60 type of compressor in various mountings for construction and engineering fields, etc.\*

etc.\*
Folder No. 43 has been issued by the Eaton Manufacturing Co. It covers engineering data on rings for S.A.E. standard bearings, housing and shaft applications, containing compact general information and ready reference on dimensions, endeuts, steel sections, etc.\*

American Institute of Bolt, Nut and Rivet Mfrs, has published the first issue of Fasteners, which is designed to provide the factual engineering data needed by executives to keep abreast of the important developments in this basic industry.\*

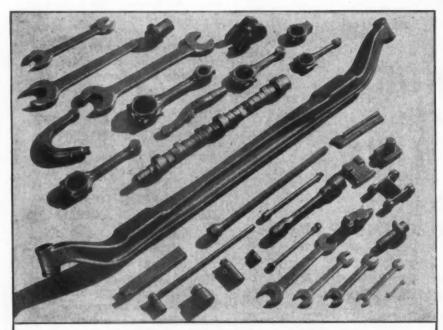
A new, illustrated catalog has been issued by The Irvington Varnish & Insulator Co., describing Irvington Fibronized Extruded Plastic Tubing. Included in the booklet are a number of product data sheets describing the characteristics and applications of a number of products, including Irv-O-Lite types XTE-30, XTW-130, etc.\*

Newcomb-Detroit Co. has issued a new catalog describing its Uni-Wash Dust Collectors, Spray Booths, Metal Parts Washers and other sheet metal equipment. It is fully illustrated including cutaway drawings of equipment mechanism and size and capacity charts. Included, also, is a 36page engineering data section.\*

\* Obtainable by subscribers within the United States through Editorial Dept. AUTOMOTIVE and ATLATION INDIFFERES. In making requests for any of these publications, be sure to give date of the issue in which announcement appeared, your name and address, company connection and title.

#### **Automatic Screw Machine Products of Aluminum**

The Harvey Machine Company, Los Angeles, Cal., has recently announced that it is now set up for high-speed production of Dural machine screw products and all sizes of nuts and bolts from % in. up, round or hexes, blank or finished and is now prepared to supply either blanks or the finished product from stock or on special order.



### Herbrand PRECISION FORGINGS

are treated in automatic electric controlled furnaces where exact regulation assures positive results

You men who are designing and building products for war needs or planning post-war developments will find Herbrand exceptionally well qualified to supply precision forgings of any size or shape up to 200 lbs. Our specialized experience dates back to 1881, the year this organization was founded.

Herbrand forgings possess an enduring, inbuilt stamina because they are scientifically heat treated by definite processes in the latest automatic electrically controlled furnaces where constant temperatures and exact regulation give positive results. You are assured forgings free from defects . . . Your inquiries are solicited.



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Spring atmospheric conditions create special rust problems that demand special precautions. Rust may show up on work left just overnight or for a week-end. Not, however, if it is protected with NOX-RUST No. 310. There are four specific rust prevention features you will find in NOX-RUST No. 310.

- Protects work against rust between machine operations.
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#### PERSONALS

D. J. Stewart, formerly assistant general manager of Barber-Colman Co., Rockford, Ill., has been made vice-president and general manager, succeeding Earle D. Parker. H. F. Collins, formerly assistant general superintendent, has been made works manager

Charles T. Lawson, general sales man-ager of the Kelvinator Div., has been ap-pointed a vice-president of the Nash-Kelvinator Corp.

Announcement of the promotion of Howard Lang to the position of assistant sales manager of The Toledo Steel Products Co. has been made. J. W. Jasperson has been made supervisor of customer relations.

The appointment of Edward D. Riordan as director of industrial relations for Graham-Paige Motors Corp. has been announced. Mr. Riordan comes to Graham-Paige from Bell Aircraft Corp.

John H. Elliott, for the past several years secretary of Landis Machine Co., has

been made general manager. Mr. will continue his duties as secretary. Mr. Elliott

Bearings Company of America has announced the election of the following offi-cers. Jack L. Straub, chairman of the board; Henry W. Jackson, president; Charles D. Addams and John I. Hartman, vice-presidents: E. E. Marshall, secretarytreasurer and Oliver J. Swartz, assistant secretary-treasurer

The Macmillan Petroleum Corp. has announced the appointment of Howard W. Cheney to the position of assistant to the president. He was formerly advertising

and sales promotion manager of the Lock-

and sales promotion manager of the Lockheed Aircraft Corp.

The appointment of C. L. Dunning as regional service manager, and the appointment of Clarence W. Shankleton as branch service manager at Pittsburgh, has been announced by the White Motor Company.

C. L. Tagglichus, Mfg. Co. has announced

announced by the White Motor Company.
C. J. Tagliabue Mfg. Co. has announced the election of A. F. Rucks as president and general manager. He succeeds the late C. D. Waters.
P. W. Litchfield has been reelected chief executive officer and chairman of the board of Goodyear Tire and Rubber Co.
Ranger Aircraft Engines Div. of Fairchild Engine and Airplane Corp., has announced the appointment of Carl O. Samuelson to the position of contracts manuelson to the position of contracts manuelson.

uelson to the position of contracts manager.

Appointment of E. F. Russell as super-intendent of the TOCCO Process Assembly Div. of The Ohio Crankshaft Co, has been announced. Mr. Russell was formerly connected with The Cleveland Graphite Bronze Co, and The Geometric Stamping Co.

George P. Torrence has assumed the presidency of Cleveland Pneumatic Tool

Co. and its subsidiary Cleveland Pneumatic Aerol, Inc. He was formerly vice-president and general manager of Rayon Machinery

Corp., Cleveland.

Corp., Cleveland.

Westinghouse Electric and Mfg. Co. has named Ellis L. Spray as assistant to the president, in charge of the Headquarters Mfg. Div., Pittsburgh. He will be concerned with coordination of the company's manufacturing divisions, quality control and methods of production.

Fred Eldean has resigned as assistant director of public relations for General Motors and will start his own public relations service with headquarters in New

Motors and will start his own public relations service with headquarters in New York City.

C. C. Carlton, vice-president of Motor Wheel Corp. and president of the Automotive & Aviation Parts Manufacturers, Inc., has been elected chairman of the newly formed OPA Automotive Parts Industry Advisory Committee. M. D. Douglas, of the Chevrolet Motor Division of GM, is vice chairman and C. O. Skinner, Washington representative of the AAPM, secretary. Other members of the committee are F. G. Allen, White Motor Co.; K. J. Ammerman, Borg-Warner Corp.; John W. Anderson, the Anderson Co.; Frederick C. Bahr, Chrysler Corp. Parts Division; C. E. Hamilton, Automotive Gear Works, Inc.; R. F. Koch, International Harvester Co.; Max Miller, GM Truck Division of GM; Burke Patterson, Thompson Products, Inc.; George Souther, Electric Auto-Lite Co.; V. E. Schirmer, Clark Equipment Co.; J. D. Eby, Wagner Electric Co.; N. A. Messe.

W. E. Schirmer, Clark Equipment Co.;
J. D. Eby, Wagner Electric Co.; N. A.
Moore, Sealed Power Corp. and R. I.
Roberge, Ford Motor Co.
Myrle E. St. Aubin, formerly field observation representative of the Distribution
Staff, has been appointed director of the
Service Section of General Motors Corp.

Service Section of General Motors Corp.

Harry W. Kaley, formerly general sales manager at Detroit, has been elected a vice-president of Ethyl Corp. with offices in New York City. Julian J. Frey, formerly manager of the technical service dept., will succeed Kaley. Richard K. Scales, former assistant, will become manager of the technical service dept.

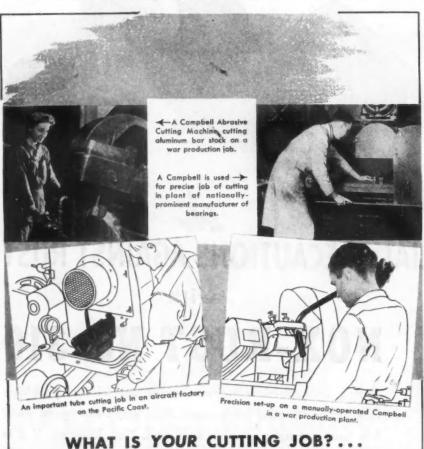
Frederick E. Moskovics, for the past three years a technical advisor to the Army Air Forces, has been appointed an indus-

Air Forces, has been appointed an industrial consultant to the A. O. Smith Corp. He is a one-time vice-president of Nor-dyke-Marmon Co. and former president of

Stutz Motor Car Co.

John K. Colgate has been elected president of Tyson Bearing Co., succeeding Ralph Maxson.

E. Olney Jones, vice-president and sales manager, has been elected to the additional post of secretary of Federal-Mogul Corp. He succeeds the late D. W. Rodger. P. J. Potter, superintendent of the company's Potter, superintendent of the company's Detroit foundries, has been named production metals engineer. Thomas J. Marshall has been appointed advertising manager. Edward P. Wright, of Dickinson, Wright, Davis, McKean & Cudlip, Detroit legal firm, has been elected to the board of di-



These 4 CAMPBELL ABRASIVE CUTTING MA-CHINES are all different. Each is cutting different stock to different dimensions none limited to the job it is doing.

CAMPBELL has the only complete range of Abrasive Cutting Machines—cutting annealed and unannealed steels, nonferrous alloys, plastics, glass and ceramics-solid bar, tubular and flat stock. What are you cutting? CAMPBELL can

give you a procedure that will do the work better, make it easier to meet schedules and lower costs.

Get further information by writing the Andrew C. Campbell Division. State what material you are cutting, length of pieces before cutting, length of cut-off pieces and the production required per hour.

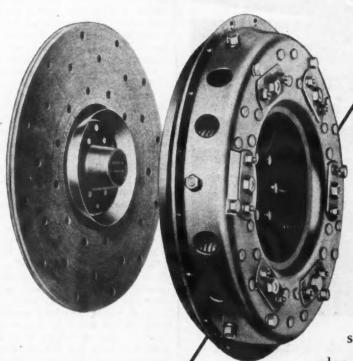


#### ABRASIVE CUTTING MACHINES

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AMERICAN CHAIN & CABLE COMPANY, Inc.

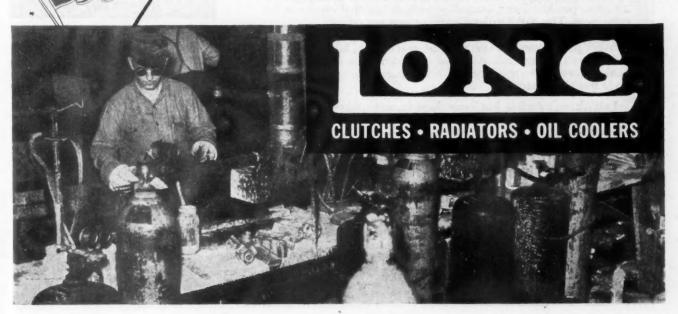
## Manpower



A large number of the men and women who work at Long have records of many years' continuous employment. Indeed, in some families, to work at Long (established 1903) is getting to be a tradition. Thus, manpower means stable, skilled personnel whose knowl-

edge of and pride in their craft is reflected in the quality of radiators, clutches and oil coolers they produce—in war and peace.

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# Alvey-Ferguson Conveyors Will Help This Stoker Plant Produce 20 Postwar Stokers Per Hour!



YOU KNOW that you must make your postwar products more economically.

You know that efficient conveyorized mass production lowers production costs.

Isn't it wise, then, to write us for a discussion of your indoor transportation problems before final plans are made to re-convert your plant to postwar production?

Perhaps we can help you—as we helped this well-known manufacturer of stokers.

The A-F Conveyor System shown above was designed to handle 20 units per hour. Sub-assembly work is handled on the roller conveyors. The A-F Trolley Conveyor acts not only as a carrying medium through dipping, painting and spraying operations, but conveys parts from storage, through machining, fabricating and finishing to storage and assembly. In addition, it acts as a stock bank releasing floor space for other purposes and eliminates wide trucking aisles.

Everything possible has been done in this plant—and will be done in yours-to make for more efficiency and lower costs. Write today.



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EQUIPMENT CONVEYING

METAL PRODUCTS CLEANING & FINISHING EQUIPMENT

#### March Production Of Aircraft

(Continued from page 48)

of engine output was up 70 per cent in 1943 over the previous year.

Aircraft production hit a new peak in March, totaling 9,118 planes, an increase of 5 per cent, or 358 planes, over This exceeded the former record of 8,802 planes produced in December. Airframe weight produced in March aggregated 103,400,000 pounds, a 9 per cent gain over February output of 81,400,000 pounds.

"As far as we can see, this may be the peak of the war in the number of planes produced," said C. E. Wilson, chairman of the Aircraft Production Board, in announcing the figures. "Virtually all companies making combat planes not only met their schedules but in notable instances exceeded them. In 4-engined bombers alone the schedule was exceeded by about 5 per cent, and the over-all aircraft schedule was exceeded by 11/2 per cent in the number of planes produced."

April schedules call for less than 9,000 planes. The Ford Willow Run plant is performing "excellently," according to Wilson's report, while the Brewster Aeronautical Corp., long a laggard under previous management, exceeded its schedule under the new Henry J. Kaiser regime. Ford recently announcd that the Willow Run plant has built more than 3,000 B-24 bombers, of which 2,000 were flown away from the adjacent airport and the remainder shipped as sub-assemblies to Tulsa, Okla., Fort Worth, Tex., and San Diego, Cal., where final assembly was completed.

#### CALENDAR.

#### Conventions and Meetings

American Chemical Society Spring Mtg. of Div. of Rubber Chemistry, New York City April 26-28

Institute of the Aeronautical Sciences— Natl. Light Aircraft Mtg., Detroit, SAE Natl. Diesel-Fuels & Lubricants

Meeting, Chicago
May 1.

SAE Natl. War-Materiel Meeting, DeJune 5-7 American Society for Testing Materials (47th Annual Meeting), New York

City SAE Natl. Transportation & Mainte-

nance Meeting, Philadelphia June 28-29 SAE Natl. West Coast Transportation & Maintenance Meeting, Portland, August 24-25 SAE Natl. Tractor Meeting, Milwau-kee Sept. 13-15

kee
SAE Natl. Aircraft Eng. & Production Mtg., Los Angeles
Oct. 5-7
SAE Natl. Fuels & Lubricants Mtg.,
Nov. 9-10

Tulsa American Chemical Society Natl. Chemical Exp., Chicago... SAE Natl. Air Cargo Mtg., Nov. 15-19 Chicago,

SAE Annual Meeting, Detroit Jan. 8-12

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AGD MODEL A



AGD MODEL SB



WE CAN SHIP
TODAY

You can get immediate shipment from a complete stock of all models and all sizes of A.G.D. Adjustable Snap Gages.

## HOW TO ORDER

State Frame Model and Frame Size.

Stipulate whether gage is to be set and sealed. Give complete marking instructions if set and sealed. For specifications see Sheffield Handbook No. 42-2, pages 150-153.



SHEFFIELD SNAP GAGE STAND

THE SHEFFIELD CORPORATION

Dayton 1, Ohio, U.S.A.

MACHINE TOOLS . GAGES . MEASURING INSTRUMENTS . CONTRACT SERVICES



#### Hydraulic and **Pneumatic Seals**

A comprehensive line of hydraulic and pneumatic seals for machinery and product applications has been brought out by the Acadia Synthetic Products Div., Western Felt Works, Chicago, Ill. These seals are produced in four basic designs-cup type, flanged or "hat"

type, "U"-type, and "V"-type. are so designed as to permit unrestricted movement of parts of hydraulic or pneumatic mechanism where celarance is essential but where no leakage is permitted. Acadia seals perform this function without binding or excessive friction.



Arcadia seal

It is of interest to find that the company has available a large variety of stock molds covering a range of sizes for each type of seal.

#### **Volt-Meter for RF-AF Applications**

Televiso Products, Inc., Chicago, Ill., is now offering a new vacuum-tube voltmeter for rf-af applications. Its special features include: high sensitivity, stabilized zero, and a built-in standard cell for calibration checks. Voltage ranges are: .5-5-50-200 ac, full scale. Frequency range is from 2 cps to 150 megacycles. The meter is said to be



Model 201 volt-meter made Televiso Products, Inc.



Now offered formed-to-size. Made of .025 cold-rolled steel. Rounded edge to prevent cutting hose. Extra strong .093 CR steel nut. Powerful, heat-treated SAE 1035 screw. Self-locking feature fully patented.

#### CHECK THESE FEATURES

- 1. Immediate clamping action.
- 2. Uniform Clamping pressure.
- 3. Attached or detached without disconnecting line.
- 4. Ample take-up for synthetic hose.
- 5. Continuous band prevents leakage.
- 6. Welded flap prevents slippage.



# Here's why Nitrocellulose Lacquer Nitrocellulose to watch! is the finish to

When you plan postwar finishes, just think of this: Nitrocellulose lacquer promises new possibilities. Don't overlook them —look them over!



Profits go up when costs go down, and the cost of finishing your product with nitrocellulose lacquer should be lowered by important changes now in process. Furthermore...

Higher solids content is the aim of extremely promising experimental work. By cutting down the number of coats required, this development will save time and labor, further reduce finishing costs. And, of course . . .



No drying equipment is needed, with its high initial cost, constant fuel and upkeep requirements, and inevitable depreciation. As always, nitrocellulose lacquers will air-dry in minutes. Their color range will be unlimited. They will still be tough, flexible, durable, resistant to water and chemicals. And above all, easy and cheap to apply and repair!



Write or call your lacquer supplier for specific aid on your finishing problems. Hercules makes no lacquers, but specializes on the manufacture of high-quality nitrocellulose and resins from which lacquers are made.



Continuous Research

Pays Off

The Hercules Continuous Research Program is constantly at work for American Industry. It is continually finding new product improvements—new methods of handling, new end uses. All users of Hercules products share in the benefits of this research.

CELLULOSE PRODUCTS DEPARTMENT

HERCULES

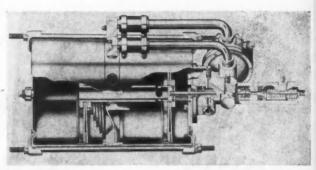
964 Market St. Wilmington 99, Delaware CL-44

accurate to 2 per cent of full scale on voltage, 2 per cent on frequency to 150 megacycles. Its resonant frequency is 350 megacycles.

This new volt-meter has automatic zero adjustment on all ranges. Readings vary 1 per cent with 10 per cent line voltage fluctuation. It is used for rf-af production and laboratory measurements by communications and electronic equipment manufacturers.

#### New Vacuum Power Braking System

A new type vacuum power braking system has been announced by the Heavy duty Hyrac brake unit



Bendix Products Division of Bendix Aviation Corporation, South Bend, Ind. This power braking system, which is

known as the Bendix BK Hydrovac, is being used on more than 500,000 U. S. and United Nations military vehicles.

The Hydrovac combines all the elements of vacuum power braking into a single unit. It is connected hydraulically, instead of mechanically, to the vehicle master brake cylinder and wheel cylinders. The hydraulic lines eliminates the need for external levers or linkage. In addition to these features, the Hydrovac combines manual actuation of the brakes with power braking and provides unimpaired manual actuation in the event the power system fails because of accidental damage.

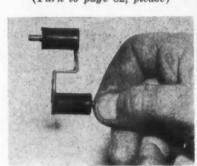
Hydrovac units now in production for installation on military vehicles of 1½ tons or over are of the "tandem power cylinder" type. This design divides the power cylinder into two compartments, each provided with a piston, thus doubling vacuum power. For lighter postwar passenger cars and vehicles requiring less braking power, the Hydrovac will be available in a single-power-cylinder design, according to the manufacturer.

#### Resilient Mounting Permits . Extremely Soft Suspension

The B. F. Goodrich Company, Akron, Ohio, has developed a new type of resilient mounting utilizing rubber or rubber-like materials. These mountings have cylinders of rubber or rubber-like materials interconnected by arms in S-fashion. This arrangement permits an extremely soft suspension under light load and allows the resilient material freedom of movement in all directions.

Handling of a variety of stresses including shear, bending, torsional or twisting is accomplished by the mounting, which also permits the material to

(Turn to page 82, please)

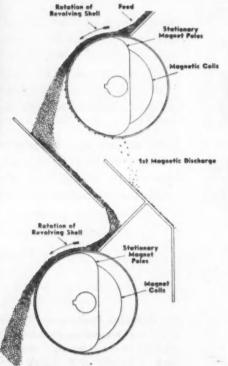


Resilient mounting developed by The B. F. Goodrich Company

For Sharper, Higher Capacity Separation of NON-FERROUS SCRAP



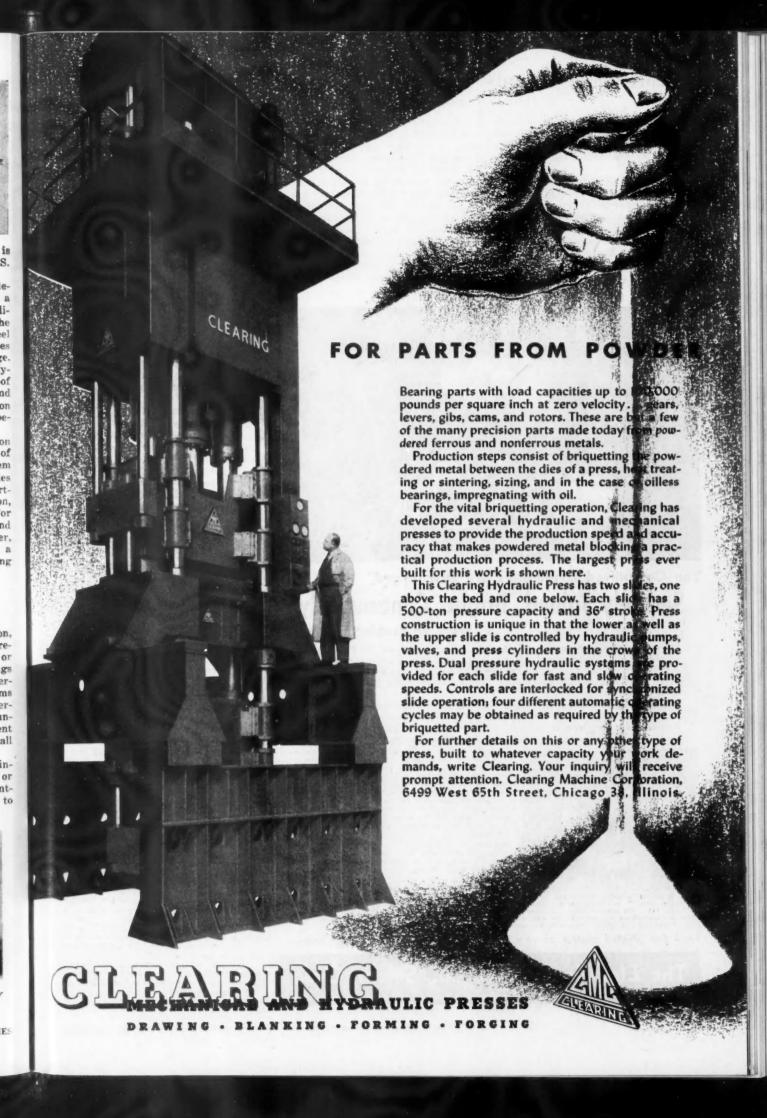
Double Drum
Separator



In many plants separating aluminum and other non-ferrous machine shop scrap, the Dings double drum separator is proving of great value in effecting cleaner separations of increased tonnages. This is one of a complete line of Dings drum type separators including agitating drums for separating badly entangled scrap. Write for Catalog 660 giving full details, capacities, etc.

DINGS MAGNETIC SEPARATOR CO. Non Mognetic Discharge 533 E. Smith 51., Milwaukee 7, Wisconsin

Dinds MAGNETIC HIGH SEPARATION DITINSTITY Above — diagrammatic illustration of operating principle of Dings double drum separator,



#### Research and Patents Under the New Deal

(Continued from page 15)

delayed for generations, or lost forever. if compelled to await the attention and abilities of the single-handed free lance inventor-or the dead hand of socialized research.

By removing all possibility of patent protection upon the occasional successes achieved in such laboratories, our judicial revolutionists should know - and probably do well understand-that the creative power of our commerciallyoperated research groups, from large to small inclusive, would shrivel toward extinction.

There would then be left, to industry and the nation, only the hopeless prospect of reliance upon tax-supported, bureaucratically-controlled and operated, socialized Federal research-wherein each scientist would attain his position and measure his expectancies solely by his capacities to perpetrate whatever political atrocities might prove necessary to enable him to retain the favor of his politically-appointed superiors.

It has seemed to me for a very long time that perhaps the greatest criticism which can be directed fairly at our industrial civilization is that its productive power, which alone defeats aggression by enslaving foreign tyrannies, also creates the luxuries which support the bureaucratic leisures by which in turn are refined, to the deceptive semblance of sanity, the lunacies by which so many civilizations have been destroyed. Only the enlightened integrity of our Congress and of our courts can immunize our nation against such lunacies.

Bureaucracy is all formula and no muscle. Muscle is developed only through the ceaseless contests of competitive realities.

Our competitive teams for invention and production in America are alone providing today that mental and moral muscle by which we are meeting and defeating, almost overnight, the longdeveloped might of foreign tyrannies, whose substitute for wholesome inventives has been the forces of regimentation and socialization-destructive always of human initiative.

God help our Congress, in these times, to hold fast to the fundamentals of the institutions upon which our incentive economy has been founded and to a system of government providing unprecedented inducements to create

and produce.

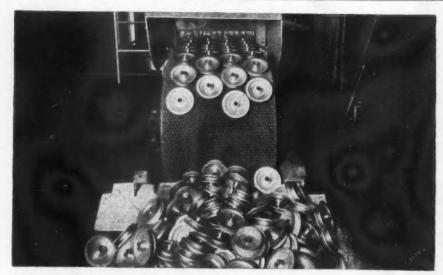
If the anti-incentive revolutionists among us today, including those injected into our judiciary, succeed in working their will, the voters of America will not have a second guess-because their guessing from there on will be done for them-by that very gang which now professes to love them-for how many generations of gruelling economic slavery none can predict.

The Teletype decision hangs like the sword of Damocles over the future of research—and of that industrial civilization which now again is proving the final fortress of human liberty.

From the opinion of Asso. Justices Arnold and Miller, Edgerton concurring, of the U. S. Court of Appeals, D. C., in the case of Louis M. Potts and Teletype Corp. vs. Conway P. Coe, Commissioner of Patents, No. 8189, Jan. 18, 1944.)

("Patents are not intended as a reward ("Patents are not intended as a reward for a highly skilled scientist who completes the final step in a technique, standing on the shoulders of others who have gone before him. By the same token they are not intended as a reward for the collective achievement of a corporate research organization. Today routine experimentation in the great corporate laboratories can produce results beyond the imagination of twenty years ago. But such contributions to industrial art are more often than not step-by-step progress of an group, not the achievement of an individual. Such an advance is the product not of inventive ability but of the financial resources and organizing ability of those who operate the laboratories. The practice of requiring the expert employes of research organiza-tions to assign in advance all their future patent rights to the organization, itself reflects the respective contributions of the organization and the individual to these so-called inventions. The 'inventor' is paid only a salary, he gets no royalties, he has no property rights in the improvements

which he helps to create.
"To give patents for such routine experimentation on a vast scale is to use the patent law to reward capital investment, and create monopolies for corporate organizers instead of men of inventive genius."-



The Completed Assemblies are Discharged Securely Joined, Bright, Continuously

... from EF Brazing Furnaces

"Greatly improved results-neater, stronger joints-60 to 75% faster, at about one-quarter the former labor cost," that briefly is the report received from the production manager of a prominent midwestern plant after installing an EF continuous brazing furnace for joining some of their assemblies.

Within a month after installing their first brazing furnace, a second similar but larger furnace was ordered for joining other products-both furnaces are now operating side by side, joining all kinds of assemblies -large and small-neatly, economically and securely.



Products difficult or expensive to make in one piece can be made in several pieces and joined—thus not only reducing the cost but actually improving the quelity and appearance. Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly and economically joined right in your production line.

Strong, leak-proof joints are made and the com-pleted unit is discharged from the furnace—clean and bright.

Any number of joints in the same product or any number of pieces can be joined at one time. The most intricate parts or assemblies are joined and the joints are as strong, or even stronger than the original parts.

Investigate This Process for Joining Your Result of a laboratory test on automobile Aluminum, Brass., Copper or Steel Parts fan pulley in which the hub was brased to With slight changes in design you may be able to a press and pressure applied. The steel webjoin your metal assemblies, neater, cheaper and broke but the brased joint held securely stronger by this method.

Send for printed matter showing various types of EE brazing furnaces

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces ... For Any Process, Product or Production

# HOLD YOUR HORSES with \*ISOdraulic Controls



In 400 B. C. it took strength and a firm hand to control four earth-bound horses pulling a battle chariot into action. NOW a pilot needs only light finger tip pressure on ADEL'S \*ISOdraulic System to control four engines developing 8,000 horsepower!

Precise control assured thru positive positioning of the slave valve in response to instructions to the master valve irrespective of altitude, temperature, vibration or pressure fluctuations. Operates independently of main hydraulic system. Available with or without positive integral locks. Ask for brochure on \*ISOdraulic Controls for aircraft, marine, industrial applications.

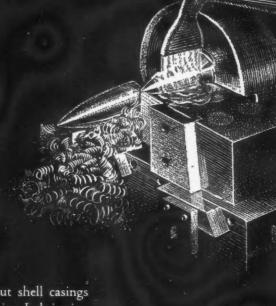
## ADEL

ADEL PRECISION PRODUCTS CORP. Burbank, Calif., Huntington, W. Va. Service Offices: Seattle, Washington Detroit, Michigan . Hagerstown, Md.

\*ISOdraulic-Trade Mark Registered \*Tested from  $-80^{\circ}F$ , to  $+200^{\circ}F$ .



EXAMPLE OF Service:



A manufacturer now turning out shell casings asked one of our Cities Service Lubrication Engineers to make a survey of his machining operations... Our engineer recommended certain changes, including the use of a new transparent blend of Cities Service Cutting Oil, which permits full visibility during the cutting operation. RESULTS: Tool life increased by 20%... cutting oil cost cut 25%... production efficiency and quality of work both improved.

More and more, it's service that counts...

and Cities Service means good service!



## Mew Products for Aircraft

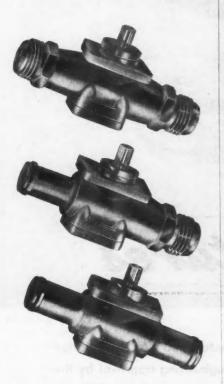
#### **Arrowmatix Fuel Line Valves**

Davidson Manufacturing Co., Los Angeles, Cal., offers three new types of aircraft fuel line valves which incorporate the latest improvements in design for valves used in conjunction with highly volatile liquids. The danger of cracking the valve body, during assembly, by over-tightening the tube fittings has been eliminated by making the AN thread integral with

furnished in three types, with ends to customers' specifications: AN-816 threads at each end, or AN-816 threads at one end and 1-in. hose fitting at the other, or 1-in. hose fittings at both ends. The valve is AN flange mounted.

Gage Set for External Taper Pipe Threads

Army-Navy specifications require the use of a set of three gages for inspection of external taper pipe threads on



Arrowmatix aircraft fuel line valves

the body. This obviates the need for special fittings and reduces weight.

Arrowmatix valves have been tested under United States Army winterization tests. They will operate under any temperature conditions ranging from as low as -65 F to above fuel boiling points. Even under these tests the valves are said to be leak-proof stick-proof. Maximum initial breakout torque ranges between 12 and 18 in.-lb, but only 6 in.-lb torque is required to move the valve to open or closed position after breakout. It operates on a 90 deg turn to either on or off with a spring detent at both positions to maintain placement. valves need no lubrication.

The new Arrowmatix valve can be

# Check THESE POINTS ON SPECIAL APPLICATION MOTORS WHEN DEVELOPING A NEW PRODUCT

- When discussing the notor for your new product, we suggest that you give careful consideration to the following points:
- 1. What suppliers have had the most experience in the design and manufacture of special application (fractional horsepower) motors?
- 2. What companies are best qualified to assume complete responsibility for the motor design or will cooperate with our engineering department?

After presenting their problem to us, many manufacturers have found that we fulfill both these important requirements.

THE BLACK & DECKER ELECTRIC CO.
KENT, OHIO



THOROUGH ENGINEERING is the basic factor behind the successful operation of this aircraft fuel pump motor and many other special application motors we have designed for all types of equipment.

Black& Decker

FRACTIONAL HORSEPOWER MOTORS

SPECIAL APPLICATION

## HI-STRESS for

HIGH TEMPERATURE APPLICATIONS

A6103H-1032 CONFORMS TO AAF SPECIFICATION

## in all Structures

• The new "Hi-Stress" SPEED NUT conforms to AAF specification No. 25531 and has been granted engineering approval by the Army Air Forces. It is interchangeable with nut plate AN362, for high temperature applications in all structures.

This new SPEED NUT is a lighter weight, one-piece integral unit. Because of its unusually low installation torque, it allows more rapid insertion of bolts or screws. Even after many removals under service conditions, this new SPEED NUT still retains its selflocking torque. Identify by SPEED NUT No. A6103H-1032.

## SPEED NUTS - THE FASTEST THING IN FASTENING TINNERMAN PRODUCTS, INC.

hydraulic fittings. Vard, Inc., Pasadena, Cal., manufactures a set of pipe ring gages which meet all requirements for gaging this type of thread. They comply with American gage design standards, and are made to Army-Navy specifications AN-GGG-P-363. These pipe ring gages are made of tool steel, hardened, ground and finished to specified tolerances.

The Vard pipe ring gages are made in three primary types: the L-1 type which is a thin ring for checking lead, pitch, diameter, and taper of threads at minimum thread length, the L-2 type for checking thread form, pitch, diameter and taper of threads at full length

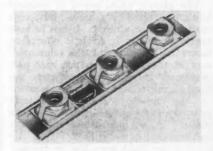


Vard gages for inspection of ex-ternal taper pipe threads on hy-draulic fittings

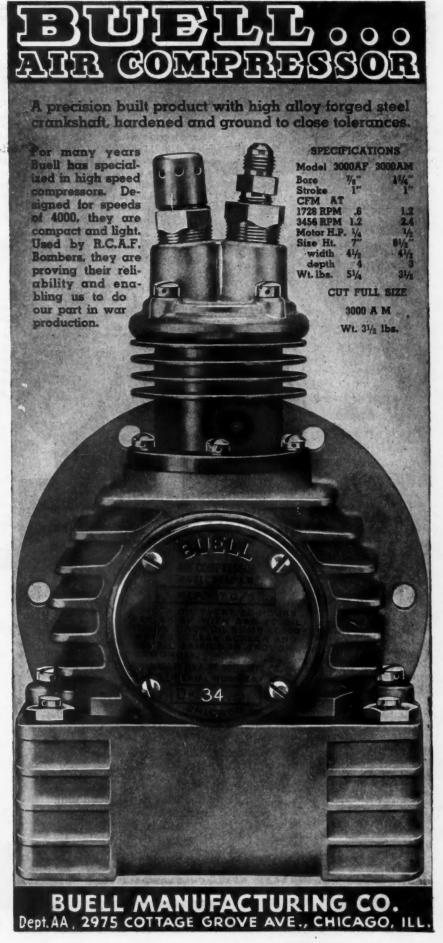
of effective thread, and the plain taper ring furnished with six steps, for checking the truncation on the major diameter taper threads. In addition to the L-1 and L-2 type ring gage, Vard manufactures these gages with minimum and maximum notches. They are identified as L-1-B and L-2-B.

#### Improved Gang Channel for Use in Aircraft

An improved gang channel for use in aircraft, marine and ordnance installa-



Click gang channels



65!

tions is being introduced by Kaynar Manufacturing Company, Los Angeles, Cal. This new gang channel is known as Click because of its use with Kaynar's Click removable nut and bolt retainer.

The gang channel consists of retainer plates and retainer springs, both of cadmium plated tempered spring steel, and an ST aluminum alloy chan-

Features of Click gang channels include easy removability, using any make of standard hex stop nuts or bolts, and high torque value, using aluminum alloy channels for light

Click gang channels are available in all standard sizes, including straight and curved sections.

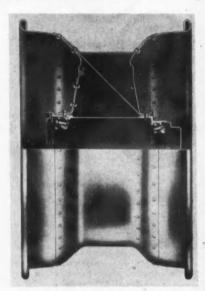
#### Aircraft Putty

E. I. du Pont de Nemours and Company, Inc., Wilmington, Del., have developed a flexible, high-adhesion aircraft putty for filling dents and cracks between riveted aluminum sheets forming aircraft wings. This new du Pont No. 228-711 aircraft putty has a buttery consistency and stays in place. It displays no tendency to flow and therefore maintains the desired surface contour. It does not sag on vertical surfaces. Both fast-drying and exceptionally low in shrinkage, the putty weighs about one-fifth less than conventional putties, always an important factor in aircraft. The product is under test by a number of major plane manufacturers.

Now available only for war uses, the du Pont aircraft putty is expected to have post-war value for such applications as the finishing of rough metal castings and railroad coaches.

#### Steel Wheel for Aircraft

The Kelsey-Hayes Wheel Company, Detroit, Mich., has brought out a steel aircraft wheel which is said to meet all the specifications and requirements of the conventional light metal wheels, such as aluminum and magnesium. This wheel is made from steel stamp-



Kelsey-Hayes steel aircraft wheel

ings of low alloy material, heat-treated, and is designed to provide the maximum of strength with minimum weight, using a riveted type of construction.

#### New Plastic Resin Board

Developed to meet urgent war emergencies by United States Rubber Company, New York, N. Y., a new plastic resin board which is being successfully used by both Army and Navy will probably find many post-war uses not only in airplane manufacture but in many other lines.

The plastic resin board is washable and not affected by gasoline, oils, acids, most alkalis or alcohol. It can be made highly decorative. Artistic effects can be created by changing the color or design of the fabric or paper base used, the hard, transparent, protective surface of the resin assuring permanence to the finished material. Colorful printed or woven designs can be seen through a surface which may have either a dull or a brilliant luster. The color of the resin may also be changed.

Advantages of the plastic board for



· Army and Navy combat vehicles. farm and roadbuilding machinery. diesel and gasoline engines, and all types of radiator hose are equipped and serviced with Central Universal Hose Clamps.



It's the clamp-power of Central Universal Hose Clamps that keeps the Army "Ducks" watertight and in action on land and water!

Made of extra-heavy rolled steel, the Universal is powerful enough to withstand abnormal pressure, stress and vibration. It is rustproof, leakproof, self-locking, 100% universal, and easy to use in hard-to-get-at places.

Standard for all service needs, it can be quickly installed or removed without disconnecting the line.

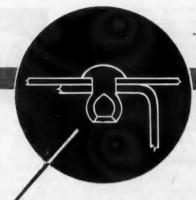
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#### CENTRAL EQUIPMENT CO.

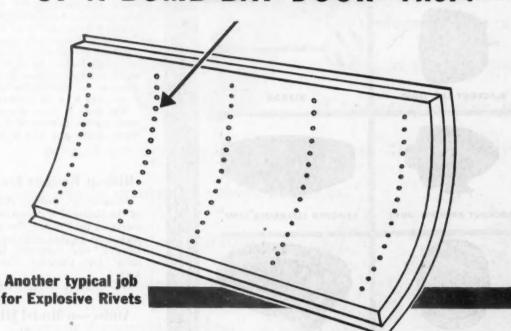
WABASH AVE., CHICAGO S, ILL.



SINGLE LENGTH UNIVERSAL CLAMP FITS HUNDREDS OF DIAMETER SIZES



# APPLYING THE INNER SKIN OF A BOMB-BAY DOOR-FAST!



When it comes to blind riveting inner skins on bomb-bay doors, nacelle doors, covers across access holes and many other jobs, Du Pont Explosive Rivets go a long way toward speeding up the work.

One operator using only one tool can easily set from 10 to 20 Explosive Rivets per minute. You simply touch the rivet head with the tip of the Du Pont

Riveting Iron. This detonates a tiny charge in the end of the rivet. A blind head is formed, setting the rivet securely in place. No further operations are necessary to complete the job.

The solid shank of Explosive Rivets, as the detail view clearly shows, provides strength where it is needed.

Look into this fast, modern way of blind riveting. It saves

man-hours, trims down costs and gives you a better, stronger completed job. Write for descriptive literature on "How to Use Explosive Rivets."

E. I. du Pont de Nemours & Co. (Inc.), Explosives Dept., 5494-H Nemours Bldg., Wilmington, Del.; 5-238-H General Motors Bldg., Detroit, Mich.; 5801-H So. Broadway, Los Angeles, California.





**EXPLOSIVE RIVETS** 

The one-piece blind fastener with a solid shank

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airplane manufacture are its light weight, half that of aluminum, its great tensile strength and its ability to withstand strains and excessive vibration. Because of these properties, it is now being used for helicopter cabin structures.

This plastic board is now the principal material used to support bulletsealing fuel cells in airplanes and is also used for de-icer tanks.

#### **Acetate Grommets**

Spun acetate grommets produced by Precision Paper Tube Co., Chicago, Ill., are made of acetate film, spirally



Acetate grommets made by Precision Paper Tube Co.

wound and laminated for greatest strength. They replace fibre or rubber grommets in aircraft, hydraulic controls, small motors and lamps. A feature is the ease of assembly made possible by Precision's method of manufacture. Grommets, which are supplied with one end spun, are inserted in place and spun over with standard drill press equipment, using special tools supplied by Precision. Articles in which these grommets are used may be painted or bake-enameled after the grommets have been applied.

#### Military Version of The Volkswagen

(Continued from page 40)

links. Each link is carried by the outer end of a torsion bar enclosed in a cross tube which, in turn, is attached to the frame of the vehicle.

Single-acting, telescopic hydraulic shock absorbers control the motion of the front end torsion bars while double-acting ones are installed at the rear.

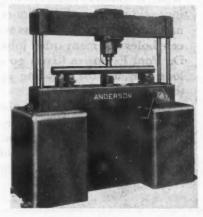
Four-wheel brakes, operated by conduit-cased steel cables, can be applied by either foot or hand. The shoes are expanded by a system of wedges which function on the toggle principle; the drums are 9 in. in diameter.

The body is made almost entirely of steel panels fabricated from 0.036 in. thick sheets and ribbed for stiffening.

#### Bishop Resigns from NADA

Charles W. Bishop, general counsel of the National Automobile Dealers Association for the past five years, has resigned to become assistant to A. van-DerZee, vice president in charge of sales for Chrysler Corp., effective May 1.

#### Anderson Model HP-0167-P Power Press



A power press with a traveling ram has been added to the line of presses made by Anderson Brothers Mfg. Co., Rockford, Ill. This press is especially adaptable for straightening cam shafts. Instead of moving the anvils, centers, and work, the ram is moved along on ball bearings. This unit has a capacity of 20,000 lbs.



Manufacturers of tanks, trucks, jeeps, planes, etc., are finding Arrow a dependable source of supply. And it is logical they should, too, for Arrow is an old hand at building these items. Arrow lighting equipment and other Arrow safety devices have a nation-wide reputation for strong, sturdy, trouble-free performance. Whether you are thinking in terms of present production or planning for postwar it will pay you to check with Arrow.

# ARROW

SAFETY DEVICE CO.

MT. HOLLY, N. J.



who went on to qualify it by saying, "It is probably the greatest single enemy of wheel bearings."

The most effective means of combating this enemy are good oil seals properly applied. Chicago Rawhide "Perfect" Oil Seals exclude not only dirt but also moisture. And they

keep the bearing lubricant where



### CHICAGO RAWHIDE MANUFACTURING CO.

1310 ELSTON AVENUE . CHICAGO, ILLINOIS

PHILADELPHIA . CLEVELAND . NEW YORK DETROIT . BOSTON . PITTSBURGH . CINCINNATI

65 Years Manufacturing Quality Mechanical Leather Goods Exclusively and now Sirvene Synthetic Products

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#### **Salvaging Airframes**

(Continued from page 34)

protruding end must be gradually tapered to avoid an abrupt change in cross-section. Added stiffeners should not be made continuous through several frames or ribs.

Plug patches (see Fig. 2) are frequently used to repair small defects in sheet metal assemblies. The plug patch consists of first cutting out the damaged area by using the least diameter hole necessary. A plug of the same thickness and material as the basic skin is then fitted to the hole. This

plug is in turn spot welded (preferably) to a square or round gusset plate having at least twice the dimensions in all directions as the hole cut in the skin. The gusset and plug assembly is then securely riveted to the skin.

When repairing a rib or frame originally having formed beads, it is considered permissible to substitute a suitable formed stiffener for the bead. Fig. 3 illustrates the repair of typical damage to the flange of a fuselage frame at a stringer cutout. The frame

flange has been replaced with a separate flange angle attached to the stringer by means of a small gusset plate.

Skin splices are sometimes made for a number of reasons. These may include original damage or removal for accessibility to some internal structure. Whenever it is necessary to splice in a new piece of skin covering, inspectors should be guided by its location. As long as they have any choice in the matter, they should refrain from making splices near other heavily riveted joints such as along the main spar flanges, or at wing bolting angles. The form of joint should be in keeping with the type used throughout the assembly. Butt joints may be replaced by lap joints when they run in a chordwise direction. In the case of spanwise lap joints in the wing covering, the leading skin should always overlap the trailing skin. Concerning the matter of riveted joints at the splice, the inspector must be guided by existing riveted joints in close proximity to the desired one. A spanwise skin seam lying aft of the main spar flange connection need have no more strength than the primary attachment at the spar. For chordwise skin splices, it is usually safe to use the same size and spacing of rivets as exist in an adjacent chordwise skin seam inboard of the new splice location. The same is true of skin splices in fuselages.

In the case of fuselage skin repairs, cognizance must be taken of discontinuities such as window openings, doors, escape hatches, etc. In ordinary stress analysis, the structural engineer generally utilizes the structure existing within one frame length of either side of the opening. Inspection of most shell type structures reveals that close rivet spacing, doublers, gussets and other reinforcements are used in the vicinity around any opening. Therefore, in making skin repairs in these localities, structural engineering assistance is a necessity.

When skin splices are made between frames or ribs, it is structurally unsound to make a simple lap or butt joint without some materially stiff backing plate to prevent the joint from being deformed. Wherever it is necessary to make a joint, as mentioned above, a gusset plate of the same thickness material as the wing skin, or one gauge heavier, should be used under the joint. This backing plate should preferably have flanged edges to add greater stiff-

In assemblies where the skin has been pre-drilled and thus serves as a template for aligning the rivets in a seam or at stringer attachments, errors sometimes arise in the location of the stringer. Then, when drilling the stringer from the skin, the holes will oftentimes not be in the desired location, and will leave low net edge distances on the stringer or pierce through the fillet. In the former, the small net edge distance will result in deformed stringer flanges when riveted. Should this become serious, the stringer should





#### Amazing! Incredible! Miraculous!

• When Barney Oldfield drove the Winton Bullet faster than "a-mile-aminute," the public rubbed its eyes. The widely heralded "Dawn of a New Era" was at hand.

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The automotive industry cast off its swaddling clothes and became an industrial giant. New jobs were created. Good roads, service stations, suburban developments, central schools, transcontinental travel, new trading centers—all sprang up in the magic trail of the motor car.

And-back of it all was the quantity production of soundly-engineered, interchange-

able, standardized, precision-built parts.

That is what cut costs. That is what assured uniform quality. That is what enabled the industry to put good-looking, efficient, comfortable, low-cost transportation into the hands of three out of four families in this country, and build up a billion dollar trucking industry.

Eaton engineers worked closely with the pioneer automotive engineers in the startling development of most of America's great cars and trucks.

Eaton and the automotive industrystill working together-are now engaged full time in war work—testing and proving many new methods—new materials—new production and engineering ideas that will beget revolutionary advances in automotive design when peace returns.

It is an honor to be associated with an industry that refuses to stand still.

### EATON

EATON MANUFACTURING COMPANY
General Offices: Cleveland, Ohio
PLANTS: CLEVELAND • DETROIT • SAGINAW
MARSHALL • BATTLE CREEK • VASSAR • MASSILLON

SUPPLIERS OF FINE PRECISION PARTS TO THE AUTOMOTIVE AND AIRCRAFT INDUSTRIES FOR MORE THAN THIRTY YEARS
-NOW, AND TILL VICTORY IS WON, DEVOTING OUR ENTIRE FACILITIES AND RESOURCES TO WAR WORK,

be replaced. In the latter case, a satisfactory repair in use for some time has been to insert a solid bar of the same material which has been closely fitted to the fillet radius and whose depth equals that of the height of the stringer. Then with the use of an extra length rivet or screw, as the case may be, the formed rivet head or nut will rest on the block and thus not be limited by the minimum space existing through the fillet. If the repair in question only involves one hole, it is advisable to extend the block on either side, thus picking up the next adjoining rivet or screw.

#### Steel Tubing Repairs

In general, splices in a tubular member should not be made in the middle of its length. This general rule is considered mandatory, in that welded splices in this region of a tubular member in compression would distort the tube to such an extent that its usefulness as a compression member would be in doubt. Whenever a member is damaged so close to a joint that it is impossible to retain a stub to which another member can be attached, that member should be replaced entirely. In the case of a continuous longeron, a

splice should be made in an adjacent

In general, no butt splices of any member between stations should be permitted. The accepted form of splice is the 30-deg scarf used in connection with an inner liner. If other dimensional conditions exist which make it necessary to use the 60-deg included angle fish-mouth type of joint, this may be used. The inner liner should be of at least the same thickness as the parent The inner liner gives added tube. bending strength to the joint and thus relieves the scarf weld of bending stresses. It has been shown repeatedly by tests that it is the basic material which fails at a welded joint just outside the line of weld.

It is better to use gussets sparingly at repaired joints. Repairs have sometimes been made by mechanics in the field by clamping a sleeve slotted longitudinally around a damaged member and then welding the entire length of each semi-sleeve. The sleeves should be scarfed at the ends and only tackwelded along their length. It must be remembered that whenever new tubes are spliced into a given structure, it is necessary that they be properly oiled and treated in the same manner as the basic assembly to prevent corrosion.

One of the greatest sources of trouble in welded steel tubular assemblies is the presence of cracks. When cracks appear, it is considered satisfactory in the majority of cases to remove the weld adjacent to the crack and to reweld. It is best to preheat the metal to a glowing red and then to apply an arc weld to fill in the crack. Through this process of preheating the rate of cooling is thereby made more uniform and will prevent additional cracks from forming.

#### Rivets and Riveting

The use of riveted joints in airframe construction has been universally adapted. Three main types have become the accepted standard. Particular reference is made to the brazier head, countersunk and flat head rivets and the use of A17ST, 17ST and 24ST rivets. The general characteristics of well driven rivets have been reviewed from time to time. However, inspection standards still vary. There are several characteristics that are considered grounds for rejection. These may be taken to be severely cracked heads, thin heads, goitered shanks, mutilated heads, set cuts, undriven heads, countersinking too deep, and overdriven

One of the most common causes for rejection lies in how the rivet, itself, fills the hole preparatory to riveting. The most serious of these difficulties is the oval or oblong hole. A careful riveter with a fair amount of experience can satisfactorily swell a nominal size rivet in an oversize round hole but seldom succeeds when the hole is oval.

When riveting a sheet to drawn or thin sheet metal rolled stringer sections where both the stringer and the

## Safe SUM DUST MAGNESIUM DUST MAGNESIUM DUST



If the dust is dangerous or explosive such as magnesium dust the AAF Type N ROTO-CLONE is the answer to your problem!

The Type N is available as shown as complete self contained booth-benches for grinding, buffing and polishing, or in large sizes for serving a central dust exhaust system. Type N collection is safe because precipitation is under liquid and the unit contains no restrictions, ledges or recesses where dust can collect. If you have a magnesium or other dust problem write us for bulletins describing the AAF equipment suited to your needs.



AMERICAN AIR FILTER COMPANY, INC., 449 CENTRAL AVE, LOUISVILLE, KY.

IN CANADA, DARLING BROTHERS, LIMITED, MONTREAL, P. Q.

ersainlite Pease "K" Continuous Wet Direct Process Developing Attachment for complete Continuous Blueprinting and Processing Machines. '700" Continuous Whiteprint Direct Process) Developing Continuous Blueprinting and Processing Machine has an actual production speed of 20 feet per minute. Pease "22" (not illustrated) has a speed of 30 feet per minute.

... MAKE ALL KINDS OF TRACING REPRODUCTIONS WITH PEASE CONTINUOUS BLUEPRINTING-PROCESSING MACHINES

BLUEPRINTS with sharp white lines and dark blue backgrounds... also Blueline prints with clear cut dark blue lines on clean white backgrounds are made better and faster, 30 feet per minute with Pease "22" (not shown). What is more, they are made at lower cost... as low as one cent (and even less) per square foot of finished prints on Pease Continuous Blueprinting and Processing Machines.

BROWNPRINTS (Negatives) and Brownline prints instead of Blueprints are made on Pease Continuous Blueprinting-Processing Machines by simply using Negative Paper and utilizing the quick change Chemical Applicator System to change from Potash to Hypo. Pease Machines are the only ones, to our knowledge, wherein Hypo is applied to both sides of the paper thus producing superior color. The prints are then dried in the continuous drier.

whiteprints (Dry Direct Process) are efficiently made by exposing Pease Multazo Whiteprint paper, or any other Dry Direct Process paper, in any Pease Printer, after which exposure the prints are developed in a separate, table style, Pease "700" Continuous Multazo Whiteprint (Dry Direct Process) Developing Machine (illustrated at left).

WET DIRECT PROCESS PRINTS are made by threading the Wet Direct Process paper through the Printer and the Pease "K" Continuous Wet Direct Process Developing Attachment (illustrated at left), which is firmly bolted to the printer and which consists of a developer tank, tray and rolls. The prints are then carried over the drier, through the wind up device which delivers them at the back of the machine.

PEASE FEATURES . . . Sliding "Vacuum-like" Contact smooths tracings, prevents errors in printing • Three Speed Lamp Control provides operation at 10, 15, or 20 amperes, minimizes running speed and drier heat changes • Actinic "No-Break" Arc Lamps burn 45 minutes without breaking arc, resume instantaneously • Horizontal "Floating" Water Wash floats prints free from tension, prevents wrinkles, stains, bleeding • Quick Change Chemical Applicator System economically allows change from Blueprints to Negatives in 30 seconds • Eight-Inch Diameter Drying Drums, thermostatically controlled, heated by gas or electricity, dry prints "flat as hung wallpaper."

PEASE SENSITIZED PAPERS are completely dependable for superior Blueprints, Blueline Prints, Brownprints (Negatives), Brownline Prints and Multazo Whiteprints (Dry Direct Process). Of course, Papers produced by other manufacturers may also be used satisfactorily.

Write for Literature and Prices . . . No obligation, of course.

THE C. F. PEASE COMPANY
2635 WEST IRVING PARK ROAD . CHICAGO 18, ILLINOIS

Pease Blueprinting Machines for all kinds of Tracing Reproductions

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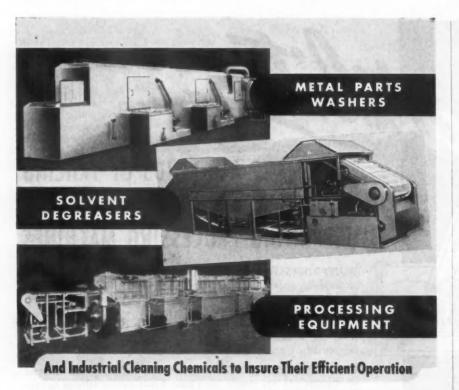
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# Are All Available From DETREX

You have in Detrex one dependable source for almost all metal cleaning needs . . . the specific type of cleaning machine best suited to your production . . . and the solvents or compounds developed to meet your particular requirements.

For unbiased recommendations on equipment and chemicals which will prove most efficient and economical for your purpose, call in a Detrex engineer.



skin have been dimpled, it occasionally happens that the swelling of the rivet head causes the dimpled stringer to crack under the driven head. These cracks propagate very rapidly. Where the cracked dimples are consistent, it is recommended that the stringer be removed entirely. Where the cracked dimples are sparsely separated (approximately 1 in 10), it has been found practicable to use a special steel washer having a recess to fit over the dimpled stringer. It is considered satisfactory to relieve the end of the crack by a small drilled hole and insert the washer over the dimple and then connect the skin stringer and washer with a well driven rivet. The clamping action of the washer will prevent further propagation of the crack.

Oversize rivets in present day airplanes must be regarded seriously. It is not true that all riveted joints utilize a rivet spacing sufficient to permit the use of the next larger size rivets indiscriminately. For this reason, it is necessary that any defects in all important rivet joints be referred to the structural salvage engineer for consideration. Where a nominal rivet spacing of four diameters is used in connection with countersunk rivets, there is not sufficient net area in the material between holes to safely permit using the next larger size rivet.

#### Stringer Repairs

In some salvage operations, it is necessary to replace lengths of wing and fuselage stringer sections. nearly all cases, stringers are the sinews of the shell structure and a damage to anyone, if left unrepaired, will weaken the entire assembly a proportionate amount. In practically all cases, stringers should not be replaced in the end bay of an assembly which contains the continuous joint to another unit. These joints are frequently made through the use of bolting angles which usually result in stress concentrations in the stringers. Due to the difference in allowable stress for the stringers acting in tension and compression, and also due to the fact that upper surface stringers are designed by allowable compressive stresses, splices in the upper surface stringers will require fewer rivets than on the lower surface. The usual form of stringer repair is by the use of splints, either used singly in the case of plain angle stringers or multiple in the case of "T" or hat section stringers. It has been found practicable to use the adjacent skin as a gusset in transferring loads from the stringer to the splint.

#### **Bolted Joints**

The inspection criteria to be followed should include an inspection of the bolt holes for size, concentricity, uniformity in depth, whether the mating parts have stepped holes or holes that are burred excessively.

### Helping the warbirds take a big bite-



Born of combat experience, the Navy's new Curtiss Helldiver is heir to all the improvements developed from battle crowded skies since Pearl Harbor. And one of the things that makes it a plane to write home about is its variable pitch propeller.

The intricate gear mechanism for these 3-bladed, full-feathering props is being built by the Detroit Gear Plant of Borg-Warner's Norge Division.

These propellers adjust to every change in altitude, wind resistance, engine speed.

The skillful engineering needed to produce gear mechanisms of such delicate sensitivity is another result of Borg-Warner's long-time principle: "design it better—make it better." More than 100 war items are today benefiting by it.

With the end of the war, this Borg-Warner principle will again be applied to the task of working with you in the automotive and aviation industries toward a better living for all America.

Partners with the automotive and aviation industries in peace and war, Borg-Warner supplies these and other essential parts . . .

CLUTCHES AND CLUTCH PARTS
GEARS
UNIVERSAL JOINTS AND DRIVE
SHAFTS
TRANSMISSIONS CARBURETORS
TIMING CHAINS
PADIATORS

RADIATORS AVIATION STEEL



#### BORG-WARNER

Peacetime makers of essential operating parts for the automotive, aviation, marine and farm implement industries, and of Norge home appliances . . . these units which form the Borg-Warner Corporation are today devoted exclusively to the needs of war: Borg & BECK • BORG-WARNER INTERNATIONAL • BORG-WARNER SERVICE PARTS • CALUMET STEEL • DETROIT GEAR AIRCRAFT PARTS • DETROIT VAPOR STOVE • INGERSOLL STEEL & DISC • LONG MANUFACTURING • MARVEL-SCHEBLER CARBURETER • MCCULLOCH ENGINEERING • MECHANICS UNIVERSAL JOINT • MORSE CHAIN • NORGE MACHINE PRODUCTS • PESCO PRODUCTS • ROCKFORD CLUTCH • SPRING DIVISION • WARNER AUTOMOTIVE PARTS • WARNER GEAR

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#### **New Production Equipment**

(Continued from page 42)

used for various types of forming and grooving operations.

Style P is a right-hand tool; Style Q is a left-hand tool. They are ground with a 15-deg. end cutting-edge angle, a 15-deg. side cutting-edge angle, a 7-deg. end relief angle, and a 7-deg. side relief angle. These tools are furnished with flat tops, so that users can grind their own side rake angle for each particular job. Five sizes of each tool are available.

A UTOMATIC tapping with precision Class III threads is said to be possible on almost any type of drill press, with the Electroaire power feed unit originated by The Bellows Company, Akron, Ohio.

The new power feed utilizes a solenoid controlled Bellows air motor to advance and retract the spindle. Feed and retraction speeds are independently controlled and are subject to infinite variation. Down feed is held under ex-



Bellows Electroaire power feed unit

act, sensitive pressure at all times preventing thread forcing. The same precise control of reverse speed is said to permit the tap to almost "float" out of the piece.

Operation of the feed is controlled by a foot switch. The feed may be synchronized to solenoid controlled jigs, work feeds and fixtures to make the entire operation automatic. The power feed may be set for multi cycle operation with indexing fixtures and dial feeds.

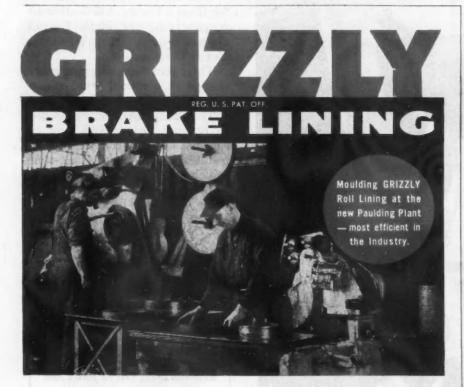
The Bellows Electroaire makes possible high speed automatic drilling with wire size drills. Drill breakage is reduced by automatically slowing the rate of feed at the break through.

N. A. WOODWORTH COMPANY, Detroit, Mich., is introducing a comparator type roll snap gage, marketed under the brand name Limitrol, which can be used either as a hand or bench type gage. It checks pitch diameter, lead, taper angle, straightness, and out of roundness. The gage is manufactured with both plain and threaded rolls, and is available in both open and closed models.

Limitrol is made in six sizes: ¼, %, ½, %, %, and % in., each being adjustable ¼ in. either way from the nominal size. Thread diameters from No. 6 to in. can be gaged within the group of gage sizes. Rolls are provided in three widths; ¾, %, and 1 in.



Limitrol comparator type roll snap gage



#### The kind of Friction that is Smooth

The combination of effective friction and smooth action is an outstanding feature of Grizzly performance.

That this combination endures undiminished throughout the entire long life of the lining is an outstanding feature of Grizzly economy.

Grizzly's constant friction efficiency results from the exclusive formula

of asbestos-friction compound developed by Grizzly engineers. The smoother action results from moulding this compound—under hundreds of tons of pressure—into a semi-rigid solid which is non-absorbent, non-abrasive, non-glazing, and will not separate.

Grizzly Brake Lining is made in rolls, segments, drilled sets and blacks.



PUSH-TITE Click!
AIR HOSE COUPLING

SOUND ENGINEERING SIMPLICITY, EASY

That Hansen Push-Tite air hose couplings are the most widely used is commonly known and the reasons for their extreme popularity are many. Good sound engineering for instance which means simplicity in design, fewer working parts, ease of operation and economy . . That's exactly what you get in Hansen Push-Tite couplings.

Note cutaway illustration of coupling

Hansen Push-Tite couplings increase production because they're fast and easy to operate . . . Increase profits because they save time . . . effort and air.

Write today for Free Industrial Catalog!

THE HANSEN MFG. CO.

1786 EAST 27TH STREET

#### **New Products**

(Continued from page 62)

be stressed simultaneously under both shear and tension.

Extension of the service field for rubber and rubber-like mountings will be accomplished by the invention, the company believes. Standard type mountings, with the rubber in shear or under compression, will not handle some cushioning problems because of limitations in deflection.

Various arrangements of the rubber cylinders and arms to which they are attached will change the rate of deflection of the new mountings in any direction.

The invention is said to be valuable in a variety of applications, including the mounting of housings for aircraft compasses and other instruments. flexible power transmission couplings and other fields where structures are mounted resiliently.

#### Double-Strap Hose Clamp

The Actus Products Company, Mt. Vernon, N. Y., is now producing an

extremely flexible double-strap hose clamp for high pressure installations. The manufacturer claims that this new clamp has great strength, and despite the double band, has the flexibility of a single band. It is so designed that a single length of the dual band will form clamps in a variety of sizes from the maximum possible with respect to



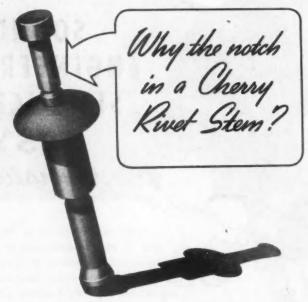
length of band or circumference, down to a % in. diameter. For example, the new Actus double-strap clamp with a 12 in. band will make a clamp to fit any hose from 3 in. to 31/2 in. in diameter. Moreover, any number of clamps may be connected end-to-end to go around any diameter or any shape of installation that may be bound by a metal band, with the added advantage that the take-up of the single clamp can be multiplied by the number of clamps used. A further advantage in addition to the greater strength and flexibility of this clamp is that a manufacturer needs to stock only clamps with a given length to fill most of his installation requirements, thereby keeping inventory at a minimum. This double-strap clamp may be installed after the hose is in place.

# Actus double-strap hose clamp

#### Improved Butadiene Type Synthetic Rubber

An improved general-purpose synthetic rubber of the butadiene type is announced by the B. F. Goodrich Company, Akron, Ohio. This synthetic, which is said to approach natural rubber in characteristics during processing, is the result of the introduction of a certain abundant natural material into the rubber making process.

The fundamental development work involved in making this synthetic rubber has been done, but it will be several months before the new material will be available. Tires made of this rubber, now undergoing extensive tests, show reduction in tread cracking and increased resistance to road wear, according to the company's announcement.



Cherry Blind Rivets of the self-plugging type are supplied with a notch in the pulling mandrel or stem.

This notch inhibits the flow of metal in the upsetting process of forming the pulling head. As a result, Cherry Rivets are more uniform and are easier to apply in blind or hard-to-get-at places.

Cherry Blind Rivets have broad tolerances in grip length and hole size for a blind rivet. But there are a few simple rules that should be followed to get the best results. These are set forth in a new, well illustrated handbook for riveters and inspectors.



RIVETERS' MANUAL B-44-Request your free copy of the 36-page Cherry Blind Rivet Manual B-44. Address Department A-109, Cherry Rivet Company, 231 Winston Street, Los Angeles 13, California.



Cherry Rivets, their manufacture and application are covered by U.S. Patents, issued and pending.

PIN A MEDAL

ON Yourself:

You get far more than just a smooth, black liquid concentrate when you use Dag colloidal graphite. A versatile group of valuable properties is also at your service. The most important of these properties are listed here. A color and a number is given to each for easy reference.

In the typical applications below, trace the record of some of these properties. You can do this simply by matching the ribbon colors against the property chart.

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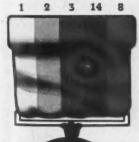
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1, 3, 14, 13, 15
CITATION: "Die and
punch life is increased
and forgings having better finish are produced
to closer tolerances with
Dag colloidal graphite
treated lubricants."



2, 6, 14, 13
CITATION: "Excellent electrical contact is obtained between copper oxide discs and adjacent metal electrodes in rectifiers when dry coatings of Dag colloidal graphite are used on the crystalline oxide surfaces."



1. 2. 3, 14. 8
CITATION: "Dag colloidal graphite is extensively used to impregnate asbestos packings for pumps handling chemicals and explosive fluids. It protects the packing against chemical action and provides safe, dry lubrication."



### Check this list

and pick out those properties which you can use. Then state your problem to us and let our engineers give

you the benefit of their experience. It is quite possible that they have already studied a parallel application. You'll pin a medal on yourself for calling in Mr. Dag.



Dag, Oildag, Aquadag, Glydag, Castordag and Prodag are registered trade marks of Acheson Colloids Corporation. Copr. 1944 by Acheson Colloids Corp.

ACHESON COLLOIDS CORPORATION

PORT HURON, MICHIGAN

Slippery — a Good Lubricant. Softer than talc

> Conducts Electricity

Withstands
Temperature Extreme

Absorbs, Radiates and Conducts Heat

Maximum Purity

6
Low Coefficient of
Expansion

Particles Bear Like Electric Charges

Insoluble in Acids and Alkalie

Black and Opaque

10 Gas Adsorbent

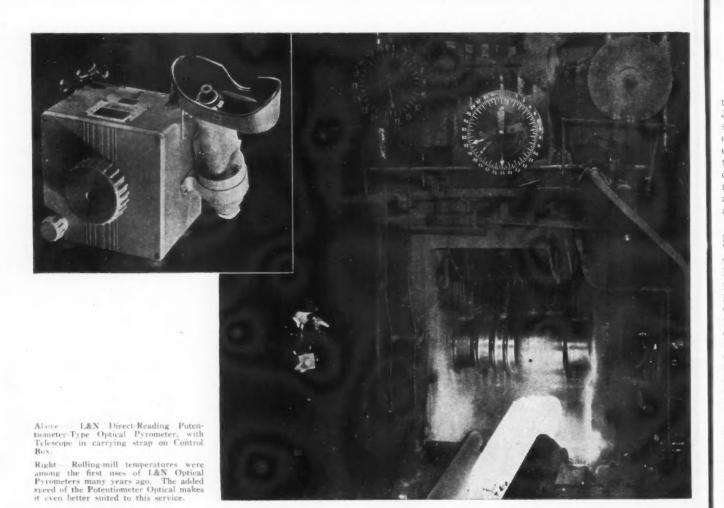
Little Photoelectric
Effect

12 Miscible with Most Fluids

Films Adhere Tenaciously and

Microscopically
Fine Particles.

An Excellent
Suspension



# SPEED and 2 Other Features Mark L&N Optical Potentiometer PYROMETERS

Speed, accuracy and a direct-reading scale are the three features which make the L&N Optical Potentiometer Pyrometer the logical choice for measuring the medium and high temperatures of industry. Lightweight and rugged construction are additional advantages in operations where the instrument is in steady service.

Operation is simple. When the user sights through the instrument's telescope, he sees the hot object with great clearness, and outlined against it he also sees the glowing filament of a small electric lamp. The user simply turns the large knob on the box until this filament vanishes against the hot object; then turns the smaller knob until a pointer on the box comes to zero; and the temperature scale turns simultaneously to the correct temperature, in degrees.

The operation is so obvious and exact that different inspectors, on the same process, will closely match each other's readings—a great advantage if more than one inspector checks a process, or if one man checks the charging temperature of a ladle and another checks its pouring temperature.

L&N Optical Pyrometers are made in three Fahrenheit and three Centigrade ranges, as follows: 1400 to 3200 F and 1400 to 5200 F for black-body temperatures, and 1400 to 3200 F for molten-metal temperatures; also 775 to 1750 C and 775 to 2800 C for black-body temperatures, and 775 to 1750 C for molten-metal temperatures.

An L&N engineer will be glad to call on you regarding the use of an L&N Optical, or will send Catalog N-33D, as you prefer.

Jrl Ad N-33D(5)





#### Decentralization at Willow Run

(Continued from page 20)

turnover dropped back to 6 per cent in January. An analysis of January quits shows that 29 per cent were 10-day quits, who left in the first 10 days of employment because they did not like the work or similar reasons, 13 per cent moved away, 10 per cent left for medical reasons, 8 per cent were needed at home and 8 per cent went into the armed forces.

More than 8000 Willow Run employes have joined the armed forces. This drain on the plant's employment was heaviest from November, 1942, to March, 1943, when it averaged over 3 per cent monthly of the plant's male personnel. In January, 1943, 3.81 per cent of the male employes-879 menwent into service. However, this has declined to less than 1 per cent monthly in recent months and in January, 1944, only 169 men from Willow Run went into service. Women comprised 36.2 per cent of the plant's employment in January, compared to a peak of nearly 39 per cent in June and July, 1943.

Willow Run has hired more than 80,000 employes in the last two years to maintain its present employment. However, much of this labor turnover has been absorbed in the training school which is run in conjunction with the plant. More than 45,000 employes have enrolled in the training school, taking from one to 10 courses each, while another 10,000 trainees from the Army Air Forces Technical Training Command also have been given courses to fit them for service as aircraft ground crews for bombers. School records show that 45,100 employes have completed courses in the school, while another 10,337 quit while in training. Among the school "graduates," 18,506 have quit since going to work in the plant, but 3555 of these had been on the job less than 10 days when they left. The school has culled out many unfit employes who otherwise might have gone to work on production before their incompetence was discovered. Basic courses in the school, which is housed in a \$750,000 building adjacent to the plant, are riveting, blueprint reading and welding. Advance courses also are given in mechanical drawing, electricity, hydraulics, job-leader training, metallurgy, shop mathematics, shop theory and engine mechanics. Current school enrollment numbers 1900 compared to a peak of 3800. Ninety instructors teach the students from the

Willow Run's remote location 30 miles from downtown Detroit and the lack of adequate housing in the immediate vicinity of the plant were factors in the high labor turnover and difficulty of adding new employes early in 1943 when the plant was just getting into production. But transportation of workers to and from Willow Run now

is operating on a more efficient basis than it did a year ago. A good share-the-ride program has been worked out by the plant's labor-management transportation advisory committee. Almost 90 per cent of the plant's employes travel to work by private automobile. Approximately 10,000 automobiles are driven to and from Willow Run every day, and there is an average of 3.1 riders per car. As the average employe drives 22 miles each way, this results

in 440,000 car miles of transportation daily, or enough to wear out 15 sets of prewar rubber tires per day. These same cars use more than 29,000 gallons of gasoline daily.

The entire Willow Run employment rolls have been broken down into departments and shifts, with the home addresses separated into zones to facilitate arrangement of the share-theride program. Detroit has been divided into 201 zones and the locations of car drivers have been spotted on a large-scale map. Fifty townships and many nearby towns, such as Wayne, Ypsilanti, Ann Arbor and Dearborn, have been zoned in a similar manner. This



Designers of equipment and machinery often find that the addition of a flange to an otherwise plain sleeve bearing not only solves the problem of end thrust but likewise simplifies the task of correctly locating the bearing in assembly.

Johnson Bronze can supply flanged bearings of any type . . . in any size . . . to your most exacting specifications. This includes flanges on one end or both ends . . . in the center or off-center . . . made from cast bronze—in any alloy . . . bronze and babbitt . . . steel and babbitt . . . or Ledaloyl, powdered bronze.

The easiest, most satisfactory method of determining whether you can use flanged bearings to advantage is to call in a Johnson Engineer. Permit him to review your applications . . . to study the operating conditions. He will base his recommendation on facts, free from prejudice. There is one located as near as your phone . . . Why not consult with him—TODAY?



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hi-g Electro-magnetic valves assure quick, accurate, and positive response in such vital aircraft operations as cabin heating, anti-icing, engine priming, fuel ahut-off, propeller feathering, wing flap and landing gear control. These valves are also used in conjunction with engine temperature control for both air and liquid cooled engines.

Unaffected by severe vibration, hi-g controls may be engine mounted with acceleration factors up to 100 or more "g's"; therefore will operate in any position regardless of vibration, change of motion or acceleration. These valves are available for all types of service such as control of aromatic or domestic gasolines and vapors, air, steam, water, anti-icing fluids and hydraulic and lubricating oils under pressure up to 3000 lbs. or more.

Available with metal or soft seats to fit any specific condition. Valves are packless, two-wire, current or non-current failure, normally open or closed, and may be furnished with various port sizes.

hi-g valves are adaptable to all mobile equipment such as tanks, tractors, trucks, buses, locomotives, ships, construction and grading equipment. Also stationary equipment such as machine tools, hydraulic presses, diesel and gasoline engines.

#### Write for Catalog 52



Warline Manufacturers of Electro-Magnetic and Temperature Controls for Aircraft @ Peacetime Producers of Automatic Pressure, Temperature, and Flow Controls

Temperature, and Flow Controls

801 ALLEN AVENUE, GLENDALE 1, CALIFORNIA
BOSTON • NEW YORK • PHILADELPHIA • DETROIT
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has enabled riders from the same departments and same shifts to be grouped together.

Public transportation provides 35 bus trips per day by vehicles of the Detroit municipal lines from Detroit, while private bus companies operate 130 buses to and from Willow Run daily. The home residence information also is used to adjust bus schedules and provide sufficient buses. All these transportation data have been kept up-to-date to meet changing employment conditions caused by turnover and shift changes as some jobs were moved out of Willow Run.

The decentralization program which has been worked out at Willow Run was not easy to achieve, especially in view of the fact that production was constantly being accelerated while the program was under way. Despite the fact that many jobs were being moved out of the plant at the time, output of bombers in the fourth quarter of 1943 was five times that for the first quarter. To direct the removal of the fixtures and machinery and to set up the manufacturing operations in the other Ford plants and in the plants of subcontractors, a Coordination Office was set up at Willow Run March 28, 1943. Several major steps were involved in farming out a job to a subcontractor. First, a careful time study was made of each job to Then a master breakdown sheet was determine costs. prepared for the job, listing all the dies, tools, jigs, fixtures, machinery and sometimes parts required. Photographs were taken of all parts or subassemblies to acquaint the subcontractor with the nature of the particular jobs. Bids then were received from interested companies and the subcontract awarded to the lowest bidder if Ford was satisfied that he could perform the job.

Then came the difficult task of moving the manufacturing operation from Willow Run to another Ford plant or the plant of the subcontractor without disrupting the flow of parts for the final assembly of the bombers. A careful study was made by the Coordination Office of the estimated length of time it would take the other plant to get into production. In order to bridge this gap, wherever possible a bank or "float" of 75 to 200 finished assemblies was built up in advance at Willow Run. On the master breakdown sheet were enumerated the number of machines, fixtures and even hand tools, required to get the other Ford or subcontractor's plant into limited production. These machines, fixtures and equipment then were moved to the other plant, while the bulk of the production for that particular part or subassembly still was carried on at Willow Run.

A pilot line then was set up in the other plant, enabling that plant to become acquainted with the job and to produce the first parts or subassemblies for submission to the inspection department at Willow Run for complete checking. Ford production men also were available to help the subcontractors get their pilot lines under way while supervisors and skilled employes of the latter often visited Willow Run to see how the particular operation functioned. In the case of other Ford plants, there likewise was an interchange of personnel to study the jobs being moved out of Willow Run. After the first parts were accepted by Willow Run, the subcontractor or other Ford plant was advised to begin production.

When the outside plant met preliminary pilot line schedules based on the percentage of machinery operating there, more fixtures and equipment were transferred from Willow Run. For a while both plants were producing the same parts or subassemblies concurrently. The "float" of those parts at Willow Run was used to meet any contingency if operations should be halted for some reason in the outside plant, possibly due to production "bugs," failure to meet inspection standards or other difficulties. Finally when the Coodination Office was reasonably sure that the outside plant could assume the full production responsibility, the remaining machines and fixtures were moved from Willow Run. Fifteen to 25 Ford cordinators assist subcontractors in keeping up to date on production methods, engineering changes and maintenace of fixtures and equipment. They also see that subcontractors are kept



#### Here are the facts...

• Many companies in the metal-working industries have recently experienced cutbacks in war contracts and there is some evidence of planning for partial reconversion to commercial production. As a result, a number of manufacturers are already circulating lists of odd steel stocks and excess inventories. More lists will appear as cancellations, design changes and manufacturing trends follow the tide of war.

While there is no real surplus of steel at the present time, there are sound reasons for a conservative buying policy. First, you will help war production by making steel available for those who need it immediately. Second, it is good business to keep your inventory at a practical working level.

Steel overstocks may be dynamite. Cancellation

of a contract or a change in design can overnight leave you with an excessive or obsolete steel inventory. There was a time when this conservative inventory policy might not have been sound from a production standpoint. However—most warehouse stocks have been built up so they now can quickly meet any demand.

Ryerson is particularly well suited to serve your day to day or emergency steel requirements. Large and complete stocks on hand for immediate shipment provide a safe, dependable source for every steel need.

Joseph T. Ryerson & Son, Inc., Steel-Service plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Pittsburgh, Philadelphia, Jersey City.

PARTIAL LIST OF STEELS IN STOCK

BARS . SHAPES . PLATES . SHEETS . TUBING . STRUCTURALS . CARBON AND ALLOY STEELS . TOOL STEEL . ALLEGHENY STAINLESS

### RYERSON STEEL-SERVICE

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Remember "Western Automatic" who changed these highly accurate tool-room-made Aileron Controls to fast war-quantity production

● One-at-a-time from a tool room was too slow for America's Axis-crushing airplane schedule. So Western Automatic production ingenuity was asked to get busy. We put these molybdenum steel aileron controls on fast precision machines, set up 10 centergrinding operations, designed mistake-proof fixtures to locate the tricky keyways and gages to hold angles within plus or minus 10 minutes — such accurate control that large diameter tolerance is well inside plus or minus .00035 inch, keyways within plus or minus .00075 inch. This kind of skill and ultramodern facilities can be highly valuable to your post-war plans. Better write us for full details now.



supplied with all materials and tools. Op to mid-January, a total of 3477 bomoer parts and subassemblies, involving 6182 dies of the original total of more than 15,000 dies at Willow Run, had been moved to outside plants. A total of 1974 jobs and 4448 dies were sent to the Ford Rouge plant, 411 subassemblies and 595 dies to the Ford Highland Park plant, 384 jobs and 575 dies to the Lincoln plant and 85 parts

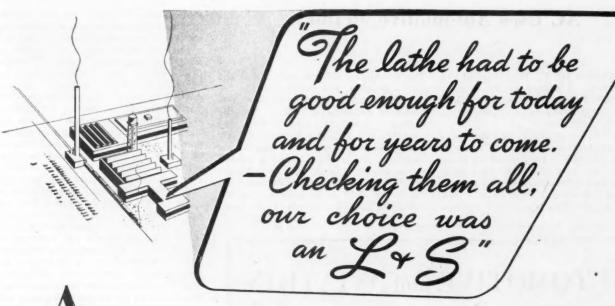
and 125 dies to the Ford Hamilton (Ohio) plant. The remainder went to

the plants of subcontractors.

Largest job farmed out was the outer wing section, which was transferred to the Highland Park plant. This involved the problem of moving the huge vertical steel fixtures, measuring 12 by 25 feet, and weighing 171/2 These were installed in tons apiece. batteries of five fixtures at Willow Run, with an overhead bridge structure that moves back and forth on a horizontal track connecting them. Finished outer wings are removed by a crane and there is no necessity for disassembling the fixture. When these fixtures were installed at Willow Run, a master wing section was built of steel in order to check the accuracy of the fixtures. These fixtures had to be set up at Highland Park in relatively the same position in batteries of five that they held at Willow Run. To achieve this result a transit was employed to locate a level line which was marked on each corner support of each fixture to be moved from Willow Run. After a fixture was dismantled at Willow Run and transported by truck to Highland Park, it was only necessary to prepare foundations of the proper height and slant and then shim up the corners so the level lines were level in conformity with the transit reading. The resulting installations checked satisfactorily with the master outer wing gage and reduced the installation time considerably. In fact, the first outer wing was delivered to Willow Run six and onehalf weeks after the first fixture was moved to Highland Park.

In the case of some critical shortage items, it was not possible to build up a sufficient "float" at Willow Run to carry the plant through the normal moving period. As an example, the pilot's control pedestal was transferred from Willow Run to the plant of a Detroit subcontractor over a week-end. Necessary electrical and air hose connections and work benches were installed in advance at the subcontractor's plant. Immediately after the shift change Saturday afternoon, all the necessary tools, fixtures and parts were loaded on trucks and hauled into the Detroit plant. Installation went on over the week-end and by Monday morning everything was set up for production in the subcontractor's plant.

Ford officials feel that the tooling methods at Willow Run, utilizing cast steel dies instead of the conventional kirksite-rubber dies of the aircraft industry, have been justified in increased and more efficient production.



GOOD lathe, properly handled, can last a long time . . . even several decades. Over many years, however, important changes occur. Cutting tools are improved. Newer metals and alloys are developed. Higher speeds are required. Automatic features are introduced transferring skill from worker to machine. All of which brings up the question: how versatile, how well adapted will your lathe be to meet such changing factors in years to come?

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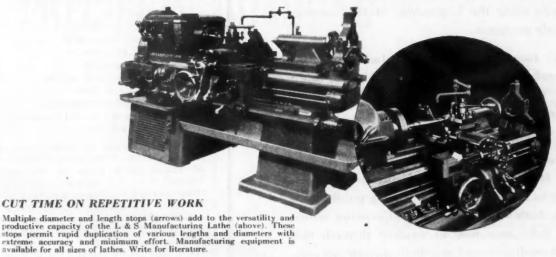
When considering lathe values and likely future requirements, you'll find it pays to look into an L & S. Fifty-two years of continuous manufacture of lathes only has resulted in what we call "engineering foresight"... a specialized ability

to make lathes unsurpassed in profitable performance year after year under changing conditions, with maximum efficiency and accuracy.

For a practical demonstration as to how "engineering foresight" can help your production—today and in years to come—call on Lodge & Shipley Engineers.

#### Prepare for the Coming Battle of Markets!

Someday—perhaps sooner than expected—you'll resume production of pre-war goods. When that day arrives, you'll want no delay or top-heavy costs. Plan now with L & S Engineers for profitable lathe performance. Be ready for "Re-Conversion" Day!



ENGINE AUTOMATIC TOOL ROOM OIL COUNTRY LATHES



CINCINNATI, 25, OHIO, U.S.A.

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April 15, 1944

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#### **AC** Uses Automotive Methods

(Continued from page 31)

60 F and plus 160 F. This entailed the development of a new rubber composition. The finished product showed less than 0.001 in. wear on the diameter in 48 hours of testing.

Now that we have sketched the background and the setting, consider some of the highlights of the production process. Let us start by noting that some of the major sub-assemblies that go into the final unit come in from outside suppliers, as has been mentioned earlier.

The remaining sub-assemblies and the final assembly and testing of the instrument are handled in a self-contained assembly department. All of the die castings, except the large frame, are produced in AC's die casting department. The machining of the various die castings, the production of precision screw machine parts, etc., is all done in AC's machine shops—in the same departments that were described in the article on the manufacture of the auto-

matic pilot. Similarly, all gear cutting is done in the self-contained screw machine and gear department—Plant 6.

For convenience, let us start with the final assembly department. Consider, first, that the assembly department has been developed for straight line production methods with each function departmentalized so as to facilitate a smooth flow of operations. To this end, the flow of materials is timed and organized by a system of some 1600 ft. of Jervis B. Webb overhead monoral conveyors fitted with special carriers. The conveyor traverses all assembly and sub-assembly stations, distributes parts to sub-assembly benches and carries sub-assemblies to assembly stations.

We start in this department with receiving inspection for the checking of all parts and sub-assemblies whatever their origin. There is provision for making minor adjustments and corrections on sub-assemblies purchased from the outside so as to reduce shipment and reshipment of rejected units. Due to the need for scrupulous care in handling delicate parts and sub-assemblies, AC has developed a scheme of special wood trays, each type designed for storing and transporting individual parts without hazard. Each tray is covered with a cellophane envelope to keep out dust and dirt. As the parts and sub-assemblies are scheduled out for the assembly lines, the trays containing these are mounted on the convevor.

For each sub-assembly built in this department, there is a row of benches. Each group is provided with the necessary tools, fixtures, gages, and machinery. Actually there are ten sub-assembly bench groups, lined up in order as follows:

- 1. Main servo
- 2. Transition shaft
- 3. Double angle servo
- 4. T/V trail cam
- 5. Drift carriage
- 6. Variable pitch screw
- 7. Climb and glide
- 8. Multiplier mechanism
- 9. T/H and S/L dial assembly
- 10. Wind vector

Final assembly operations can be noted topically. First is the installation of sub-assembly units in the main frame. For this purpose, the main frame casting is fitted in a rigid fixture where it is carefully aligned and accurately checked with suitable gages to determine the principal axis which controls the positioning of the sub-assemblies. The frame remains fixed in this fixture for its entire trip through this phase.

The frame now travels progressively from station to station, each one adding a sub-assembly unit. At each stage, the unit is carefully lined up, and when established in its proper relation to mating units, it is fixed by drilling for fastening pins or dowels.

At the end of the assembly line, the entire unit is torn apart, and the com(Turn to page 93, please)

# AUTOMOTIVE and AVIATION INDUSTRIES

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Automotive and Aviation Industries is the industrial authority in the automotive and aviation manufacturing fields.

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duction needs, Perfex devoutly hopes soon to be filling postwar requirements.

Perfex manufactures thread plugs, thread rings, plain plugs, plain rings and special thread gages to blueprint. For complete infor-mation and prices wire or write our sales department today.

GE & TOO 3601 Gaylord

(PERFEX)



April 15, 1944

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ponents for a given instrument kept together. The purpose of this procedure is to permit the removal of chips, dirt and oil accumulated during the assembly stages. These parts now are transferred to another conveyor line and transported to the next assembly group. Here the parts are cleaned by spraying with Stanisol solution, removing the spray and drying by an airblast.

Families of parts and sub-assemblies thus cleaned now proceed through the phase of re-assembly. This is a relatively simple operation since the elements will go together freely and will line up perfectly with the pin and dowel location previously provided. For this operation, in a typical case, the frame is lined up on a turntable so as to afford ready access to all parts of the frame. Each turntable is provided with a multiplicity of small bins containing the essential fastenings.

For the final operation on this line, the frame, while mounted in its fixture, is held in a special turntable fitted with hinges which permits the operator to lower the instrument onto a tray fitted with rollers. At this point the instrument is fitted with the shock assembly.

Instruments are inspected, then transferred onto another conveyor ready for the journey through the various stages of calibration and final testing. It may be observed that since all of the operators in the assembly department are women, elaborate means are provided for easing the burden of moving instruments and of transferring them from and onto the monorail conveyors. For this purpose is provided a system of lifts or elevator stations, operated by air, which may be raised to the level of the lower end of the carrier on the conveyor line.

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First of the calibration tests is for timing. Next major step is altimeter calibration in a vacuum box where it is possible to simulate altitude from sea level to 23,000 feet. Then comes the sine test for checking servo element response, and final checks. This is followed by torque checks to assure the standard output of the several driving elements. The final step is Air Corps acceptance followed by the assembly of protective attachments for export packaging.

Now for a glimpse of some of the machine shop operations. Consider first the machining of several of the die castings. Remember that these are light slender pieces requiring careful handling. In some instances, it is necessary to normalize the castings after rough machining and sometimes the normalizing operation is repeated to assure freedom from strain that might cause misalignment.

Easily the most important part is the main base plate or housing. The casting is normalized before machining, then rough machined, again normalized to release strains, then finish machined. First step before machining is to lay the casting on a surface plate and straighten for true plane. This is followed by several drilling operations on

Walker-Turner radial drills to provide dowel locations from which all subsequent drilling operations are located. Next comes a series of rough milling and pad milling operations on single-spindle and two-spindle Pratt & Whitney profilers. A Cincinnati dial type milling machine is used for milling pads on four sides. At this stage the casting is normalized to relieve rough machining strains. The original dowel locations are rebored on the Walker-Turner radial in preparation for final machining.

The casting is checked once more on the surface plate and proceeds to further milling operations on P & W profilers. This is followed by a long series of drilling operations on Natco multiple spindle drills; reaming of holes on six-spindle Footburt drill presses; drilling in six-spindle Footburt drills; semifinish milling on P & W single-spindle and three-spindle profilers; tapping holes in Natco multiple-spindle drills; tapping some single holes on a six-spindle Footburt; chamfering operations by hand; and finish-milling pads on a two-spindle P & W profiler. Following machining, the casting is washed, inspected, painted, dried, and final inspected.

Take another of the castings—the gear case block. This is an example of



To Improve Quality—Its perfect atomization assures finer finishing at top speed. Micrometer calibrated spray pattern control provides precise, easy adjustment for any job.

To Slash Replacement Costs and Headaches—The sturdy construction—with all working parts enclosed in strong, machined brass body—protects against damage and assures longer life. Floating air valve takes up wear, prevents leaks. The CUB stays on the job!

These special advantages of the Paasche High Production Airbrush are typical of the superior quality features to be found in the entire Paasche line. Get the facts and you'll get Paasche Airpainting Equipment.

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the small castings in which from one to three different sets of holes are precision-bored on an Ex-Cell-O boring machine, using single-end or double-end machines as the case may be. We might mention that all machining operations, wherever feasible, on the die castings are done with Carboloy-tipped tools. In the case of the small precision-bored holes, the tip is welded onto the tool holder instead of using a flycutter.

Small castings, such as this one, are normalized in a Lindberg furnace. Pads are milled in P & W profilers; holes are drilled in separate settings in a Footburt drill press; spot-faced on an Ailen sensitive drill; then the boss is straddle-milled in a Cincinnati plain miller and the end milled square on another Cincinnati mill; various holes are rough-drilled on a Footburt, a hole counter-bored on an Allen single-spindle sensitive drill, spot-faced on a Footburt; then burred. In between there are a number of hand burring and cleaning steps.

The casting now is normalized in a Lindberg furnace to relieve strains and is ready for finish-machining. First operation is that of checking for flatness and lapping on a #2A Ultra-Lap machine. This is followed by drilling several holes on Allen bench type drill presses. The next operation is precision-boring of three sets of holes in three axial locations in a four-spindle double-end Ex-Cell-O machine. work is mounted on a plate of suitable design and for the first operation they bore one hole 0.4375 in. plus 0.0002 minus 0.0004; and one hole 0.3748 in. plus 0.0006 minus 0.0000. The work is then indexed to its second position in the fixture for line boring two holes, 0.1875 in. plus 0.0003 minus 0.0002. Now the plate is removed from the work-holding fixture and turned 90 deg. on a lower station to take a 0.3748 in. hole, plus 0.0006 minus 0.0000. This is an interesting example of work planning in which a single machine with a single universal fixture is employed for the boring of a series of holes of different size and different axes. It may be noted too, that this department features a number of the familiar Gorton profilers which are used for milling operations on some of the small castings.

Turning to the steel parts produced on screw machines or turret lathes, we can take one example as being typical of the general run—the lead screw, a basic part of one of the sub-assemblies. This is made of stainless steel bar stock, turned on a Warner & Swasey turret lathe. The work is chucked in another W & S for turning, facing, and chamfering, then centered in a bench lathe. The body of the screw is ground on a #5 Brown & Sharpe grinder, holding the 0.3119 diameter to plus 0.0000 minus 0.0003. In turn, the tennons on both ends are ground on B & S machines, holding the same tolerances.

The Acme thread is produced in one operation on a Jones & Lamson precision thread grinder, being filed by hand, burred and polished. Thread form on all threaded parts is checked in a J & L Comparator. The thread is checked for size in P & W Electrolimit gages, using the three-wire system for the purpose. It may be noted that Electro-limit gages are installed on each of the J & L thread grinders to facilitate inspection by the operator.

The foregoing is intended to give review of the machining operations, using a few examples typical of the range of the work. The point to emphasize is that all of the parts are small and delicate and must be held to extremely fine tolerances dimensionally. This objective is achieved by expert routing of operations, by skillful sub-division of operational steps, by the use of welldesigned and rigid work-holding fixtures. A good example of the latter is the practice of fitting some of the small castings into a carrier fixture in which the work is retained during all stages of drilling and boring so as not to disturb the accurate relationship of these operations. To the foregoing might be added the fact that for precision work of this character AC has been wise in its selection of the finest production equipment available today.



Here's a unit worth investigating! A PORTABLE enginedriven power plant, the Nite-Hawk Aero-Starter gets your planes into the air quicker. Also furnishes power for testing landing gear, turrets, etc. Equipped with floodlights for night operations. Air compressor attachment available.

Write for Bulletin NH12A



# GEARGRIND PERFORMS TWO OPERATIONS AT ONCE ...

## Finish Grinding Time Cut in Half

In grinding an overrunning clutch for an aircraft supercharger part, one GEARGRIND Machine, equipped with dual grinding wheels and a special trimmer, grinds both flat and radius at the same time.

Originally these two operations were performed separately, involving either break-down and setup when both were performed on the same machine, or the use of two machines on a production basis.

GEARGRIND engineers developed the dual wheel trimmer, while continuing the conventional GEAR-GRIND method of wheel dressing, using the extended stroke of the table as wheel dressing is required.

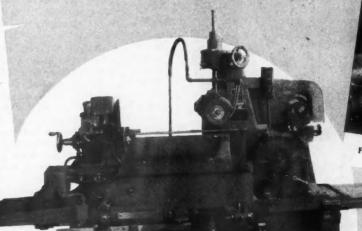
Similar methods may fit into your program, where production, finish and accuracy are vital factors. We shall be glad to discuss the possibilities with you.



ans special inimmer provides hydraulic operation of the diamond tool, here shown in position for dressing the flat strinding wheel.



The radius grinding wheel is dressed with the diamond tool in this position.



Flat and radius faces are both ground at the same time.



With special dual wheel trimms and two grinding wheels.



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MACHINE COMPANY

#### How to Assure America's Oil Supply

(Continued from page 17)

is protected by law from monopolistic practices and anti-social activities on the part of business, so the public interest should be safeguarded from the disruptive effects of improvised policies on the part of government that may have narrow or short-sighted objectives. Some of these safeguards can be provided by consultations between government and industry on all actions having to do with policy.

A dynamic factor that has made it possible for the industry to grow so consistently in the face of repeated predictions that we were running out of oil, is the development of technological methods in every branch of the industry. This technical progress is the result of competitive research within the industry and constitutes one of the great American achievements during the past quarter-century. Instrumental in promoting this invaluable asset has been the general policy of making new developments available for license on reasonable terms. It is vital to our

future growth and development that such processes be encouraged rather than discouraged as they would be by proposals for governmental domination of research, emasculation of our patent system, or entry by the government into competitive research in fields where private research is adequately covering the ground.

The oil industry has constantly advanced in the science of finding, producing, and refining oil. This constant technological improvement should be encouraged. It has been the means whereby our oil reserves have been vastly increased and the production of the most necessary products from crude

greatly improved.

Technological advance has been one of the driving forces evident between World Wars I and II and responsible for the preparedness of the oil industry to meet the needs of modern mechanized warfare for oil in the quantity and kind demanded.

The static view of our proven oil reserves as amounting to only so many years' supply is completely misleading and such calculations are capable of doing great damage to our future oil situation. The proven reserve is merely a given point in a moving inventory. The static estimate takes no account of all the dynamic factors that have been all important in meeting our requirements.

The domestic proven oil reserve has declined less than one-tenth of one per cent during the second year of our participation in the war, having actually increased the first year, while the oil reserves of our nationals abroad have

steadily increased.

The proven domestic crude oil reserves, officially stated at approximately 20 billion barrels, understates the true conditions. It does not include oil in unproved portions of proven fields, casinghead gasoline, oil that may become available by secondary recovery methods, oil yet to be discovered. and the oil equivalent of available These additions will be natural gas. very large, doubtless exceeding our discoveries to date. Nor does the estimate include the oil which may be recovered beyond the present estimates of proven oil in proven fields by reason of the constantly improving techniques in primary production methods. Such estimates are based on the amounts of oil recoverable at present prices by present recovery methods. Such estimates also take no account of the oil that may be extracted or synthetized from vast deposits of other carbon resources, such as coal and oil-shales.

The technology of converting natural gas into gasoline is so close to a commercial status at present values that its utilization when needed can be left to the efforts of private enterprise.

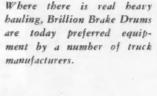
The techniques involved in the manufacture of oil products from oil-shale and coal, while entirely practical from an engineering viewpoint, represent costs substantially above present values



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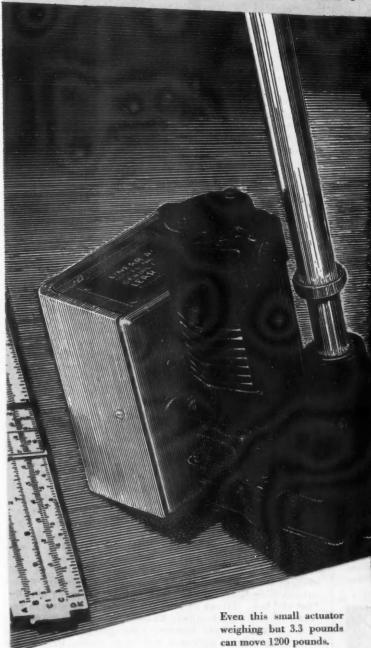
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WE wouldn't tell you how fast America's fighting planes go. That's a military secret.

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It's done by such mechanisms as you see in the picture.

They are called Lear Actuators.

They are powerful. Some can push up to 75,000 pounds.

They are light. That's a "must" in aircraft.

They are small. They have to fit in available space.

A good many preconceived notions had to go by the board to meet all these requirements. For example, the little electric motor that runs them is full of revolutionary engineering refinements.

Every man and every minute we have now can't make all the motors and actuators that we would like to deliver for Uncle Sam's aircraft.

But the day is coming when they will have different jobs to do. New jobs on peacetime products—perhaps like steering ocean liners, or parking cars, or things we've never thought of.

That is one reason for this advertisement. We want to know who can use an actuator or a motor like these.

Another reason is, we want you to know that there is available the kind of thinking and engineering which have produced these and some 250 other Lear products,

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# "Hero-Seal"

This outstandingly successful new type hose clamp was specially designed for aircraft applications, and has proved its dependability with millions now in service. It meets, or exceeds, all requirements of Army-Navy Specifications AN748 and AN-FF-C406a.



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and therefore are not commercial until oil prices rise substantially or these costs have been reduced. Because of this time gap, it might be appropriate for the government to carry on technological developments to a reasonable degree, although such efforts would be more advantageously directed to development research than to large-scale installations, especially pending the acquisition of synthetic techniques developed in Germany during the war. The government might also inaugurate extensive investigations in the classification of oil-shale deposits by grades, and in the problems and costs of mining oil-shale. At the same time, considerable industry research is under way in this field and if oil rises in value there will be a natural intensification of these efforts.

Discovery of oil in the United States has received renewed impetus from time to time from the development of new exploration techniques. The sequence has been surface geology, core-drilling, sub-surface correlations, the refraction seismograph, the reflection seismograph, soil analysis, and many others. Discovery would be greatly facilitated by the development of a new exploration tool. While this field is being vigorously prosecuted by the industry, the technical advances in many fields have been so accelerated by the war that the government could be genuinely helpful by directing funds to basic researches seeking to develop new principles which might be useful in exploration.

Easily accessible foreign reserves in friendly nations and owned and operated by United States nationals offer the greatest possible help for emergency needs. Special thought should be given to increasing the already large reserves of this type by measures designed to augment the confidence, trust, and friendliness of nations in the Western Hemisphere.

Any policies making for the impairment of the confidence of our neighbors through the direct or indirect participation of our government in any phase of the oil business, either here or abroad, whether in production, transportation, refining, or marketing, should be avoided.

The national security and economic stability of the United States can be greatly enhanced by adequate world oil developments, under the leadership of United States nationals.

The principles and procedures submitted, on Nov. 4, 1943, to the Petroleum Administrator for War by Foreign Operations Committee advisory to the Administrator. in a document entitled "A Foreign Oil Policy for the United States," is recommended as a clear and acceptable

The government is urged to give full consideration to this document, which has the endorsement of the National

Oil Policy Committee.

An international instrument of consultation and collaboration, without power of enforcement and in which there is joint government-industry representation, is deemed essential to further world oil developments on a basis of mutual respect.

The public interest in oil can best be served by a vigorous, competitive industry, guided by private initiative. Our oil future cannot be charted in advance; our best procedure is to maintain a vigorous, dynamic oil industry competent to meet the problems as they arise and able to create new approaches through dynamic action.

The domestic oil industry needs no further Federal administrative machinery. For over a decade, the oil industry has been operating under one of the most effective and efficient industrial policies in our entire economy. system needs freedom to evolve further, and anything to impair it or destroy it would prove unfortunate, if not disastrons.

Important elements which implement the effective and efficient industrial oil policies referred to include: State conservation laws; The Interestate Oil Compact; Connally "hot oil" law; Bureau of Mines certification of market demand to State authorities; Federal tax policy on deple-All these have received thorough public scrutiny and Congressional approval and have proved themselves over a considerable period as to their soundness both in



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relation to the public interest and to the stability of the national economy. All should be continued. Comprehensive State conservation laws effectively administered are essential. The emergency controls necessary to the successful conduct of the war should expire with the emergency.

The operations of United States nationals in foreign fields need diplomatic support and machinery for international consultation. Our nationals operating in oil abroad need to have the political risks reduced by intelligent and sympathetic diplomatic support by the government. This does not mean government participation which should

be rigorously avoided in any phase of their operations.

As with the domestic situation, there is a remarkable parallel in the international oil situation at the end of World War I and today. Statements that the drain on United States oil production and reserves would mean that soon this country would have to get most of its petroleum supplies from foreign countries were given wide publicity. These were seized upon as reasons why the government should develop an oil policy that would include government participation in foreign oil operations.

In January, 1921, a bill was intro-

duced in Congress for an export oil embargo from the United States to any country discriminating against American oil interests. The question of national spheres of interest and national oil monopolies was fiercely debated in the press, with "closed door" advocates heard at home and abroad. For several years after World War I the need for encouragement of American industry in the development of foreign oil sources was the subject of our State Department representation on many fronts, and fortunately for the world the "open door" policy won out in most countries. This has enabled world production largely under free competitive enterprise to increase from 503,515,000 barrels in 1918 to 2,224,882,000 barrels in 1941, or 342 per cent. The United States increased its annual production from 355,928,000 barrels to 1,402,-228,000 barrels, or 294 per cent. countries outside the United States increased their annual production from 147,587,000 barrels to 822,654,000 barrels, or 457 per cent.

The varying and conflicting oil policies of the various nations need to be brought into harmony with the objective of orderly and efficient world oil development. To this end, international machinery is necessary. The Government of the United States should take the lead in bringing about this necessary coordination. It should develop, deliberately and only after mature study, an oil policy, both domestic and foreign, based upon experience, knowledge, and insight. Such a policy canont be successfully formulated without consultation with the industry and should not be so attempted. All measures determinative of postwar policy should be held in abeyance until a final policy is determined. It is particularly urged that no definite action be taken by any arm of the government committing the people of our nation to long-range future entanglements of a grave and indeterminate character in foreign countries, without first having these proposed commitments considered and approved by the Congress of the United States.

#### Adhesive for Bonding Wood to Metal

Pliobond, a new type of rubberlike adhesive, is a recent development of The Goodyear Tire & Rubber Company, Akron, Ohio. By means of the new adhesive, it is possible to cement a layer of plywood only one forty-eighth of an inch in thickness to a metal surface.

A metal sheet of any thickness thus covered with a layer of any desired wood, can then be handled in the same fashion as the sheet alone. It can be bent into any chosen shape or form or cut with a shears or stamping press without cracking the wood or pulling it loose from the metal. Other metal units can be welded to the back of the metal sheet.



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#### Russian PE-2 Bomber

(Continued from page 23)

in the wing structure at the side of the engine. The air intakes are in the leading edge of the wing; air discharge is controlled by electrically operated gills or louvers.

Unorthodox features are associated with the fuel feed to the carburetors and the replenishment of the fuel tanks. As regards fuel delivery, this is effected through a service tank of three U. S. gal capacity located at the rear of each engine between the engine bearers. This small tank receives fuel

from the various storage tanks, of which there are nine in all, one in the fuselage and eight in the wings. Including the two service tanks, the tankage has a capacity of 396 U.S. gal.

From each service tank the fuel is delivered to the carburetors by a remote controlled pump below the tank. This pump is driven by oil pressure as follows. At the very front of the engine is a small tank containing an easy-flowing oil, which is piped to a gear-type pump at the rear of and driven by the engine. From this pump the oil is discharged under pressure through a flexible pipe to a paddle or wing-type fuel pump below the service fuel tank. This latter pump is the one that actually delivers fuel to the carburetors. A flexible return pipe leads the pressure oil back to the tank at the front of the engine. This arrangement is said to have enabled the length of the fuel piping to be kept very low and so reduce fire risk in the vicinity of the engine.

The main fuel tanks are replenished from a single point on each engine nacelle, where there is a "pocket" housing a hose connection, with a built-in non-return valve to prevent fuel from escaping when the cap is removed for connecting the hose from the tanker. All fuel tanks are sheathed with a selfsealing layer of vulcanized sponge rubber and are provided with a device for introducing an inert gas (nitrogen) into the air space above fuel level as a means of fire protection in case of bullet penetration.

Operation of all controls is effected by electric servos, of which there are 18, viz. one each for the undercarriage hydraulic gear, undercarriage control valve, diving brakes and wing flaps; two each for the oil radiators, propeller pitch control and booster gear control and four each for the coolant radiator

gills and the trimming tabs.

The hydraulic gear operating the undercarriage is not supplied with pressure oil by an engine-driven pump, as usual, but has a separate electricallydriven pump operating only the re-tracting gear for the two landing wheels and the tail wheel. To operate the undercarriage the pilot, therefore, closes a switch instead of actuating a valve in the hydraulic circuit.

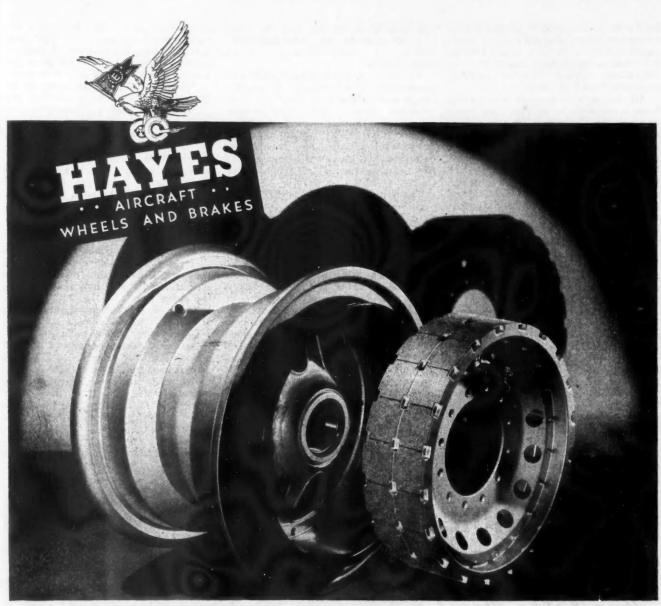
Three different armament arrangements have been observed on PE-2 dive bombers. In the first there are four 7.62-mm Shkas machine-guns; in the second there are two 7.62-mm machine-guns and two 12.7-mm Berezina cannon, while in the third there are four 7.62-mm machine-guns and two 12.7-mm cannon.

The standard bomb load is 1320 lb, but up to 2200 lb may be carried as the "maximum permissible" load. Bomb racks are provided as follows: Two fuselage bays for 220 lb and 110 lb bombs, four mid-wing racks for bombs of various sizes and two chutes in the engine nacelles for 220 lb and 110 lb bombs. Following are optional bomb loading arrangements:

Bomb Weight	In Bomb Bay	In External Racks	Total Weight
1100 lb	-	2	2200 lb
550 lb	-	4	2200 lb
440 lb	4114	4	1760 lb
330 lb		4	1320 lb
220 lb	- 6	4	2200 lb
110 lb	6	4	1100 lb

All seats are provided with 8 to 9-mm rear armor protection, the pilot's seat having 6-mm side armor in addition. In some cases the underside of the fuselage is also partially armored. The pilot's back armor is hinged to enable





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half to be folded forward to gain access to the somewhat cramped cockpit. The upper section of the back armor affords head cover, being hood-shaped to give protection against missiles coming obliquely from the rear.

All bombs are released electrically from a central control board, enabling any number of bombs to be released in salvos, or sticks with any desired time interval. Actual release is not, however, effected by solenoids, but by electrically-fired explosive cartridges, the blast from which operates a plunger releasing the slip. The bomb slips are of small dimensions and instantly removable. The racks in the fuselage bays are suspended at both outer walls on vertical brackets with a quick-release mechanism. Two hooks for bomb hoisting are provided and a hoisting gear consisting of a wire cable of 5-mm diam and a simple winch in the fuselage.

To enable the gunner to fire backwards and downwards, the rear machine gun is extended through an aperture in the bottom of the fuselage. The gunner lies prone inside the fuselage and controls the gun by means of two handles, one with a firing button. The extended gun is laid on the target by means of a reflector sight of the periscope type. The optical system of the sight consists of two telescope tubes set at 110 deg with the necessary lenses and prisms and a graticule. The angle between the line of vision and the

line of sight is 160 deg, and the angle of sight is 40-42 deg. The magnification is 1 to 1 and the weight of the sight  $6\frac{1}{2}$  lb.

The entire assembly of gun and sight is mounted in a vertically retractable cradle and balanced by a spring counterpoise. Ammunition supply is contained in a magazine in the fuselage, whence it is fed by belt to the gun. Large oval windows are provided at both sides and above the gunner's position, for purposes of illumination chiefly.

The flying qualities of the PE-2 have

been described by German pilots who have tested examples of the type force-landed behind their lines, as follows: "Rudder sensitive; aircraft goes into a spin after a careless turn or mistakes in horizontal flight. In spite of the high landing speed it is an easy machine to land. It is, indeed, a very good aircraft, steady in diving and very efficient in dive-bombing." According to statements of Russian pilots captured by the Germans, the latest version of the PE-2 has two 14-cylinder M-82 engines (aircooled radial, presumably) of 1600 hp each.

#### **Production Version of Mars Flying Boat**

(Continued from page 21)

centers. The floor is also fitted with metal skid strips for sliding heavy cargo and aluminum alloy tracks both fore and aft and athwart ships for handling engine transportation dollies. Additional light is let into the interior of the hull by the addition of five extra port-holes on each side.

Immediately aft of the cargo hold, in the space provided by moving the second step aft, is a stairway to the upper deck replacing the ladder arrangement on the prototype. As on the lower deck, the bulkheads on the upper deck have been replaced by frames—in this case the opening is 82 in. wide. The entire upper deck is floored with Panelyte plastic flooring developed by Martin engineers. Washroom facilities on the JRM-1 have been transferred to the tail section which is reached from the upper deck.

The new production version of the Mars has been designed to fly at weights up to 145,000 pounds as compared to a design weight of 140,000 pounds for the prototype. The first airplanes of the new contract, expected to be ready early next year, will be powered with four 2200 horsepower Wright Cyclone engines, but the design provides for a switch to larger and more powerful engines should the latter become available, which will permit a considerable increase in gross weight and payload.

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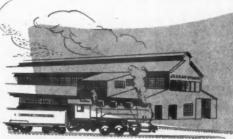
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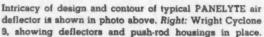
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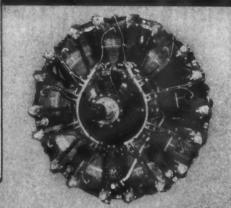
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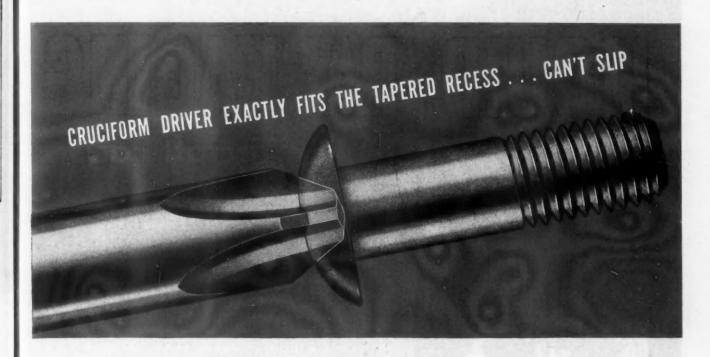
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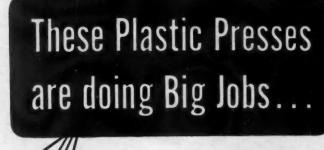
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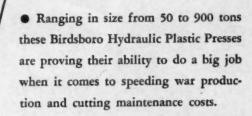


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# WHY Roto-Matic \* DRILLING MACHINES WILL INCREASE YOUR **PRODUCTION**

The Roto-Matic\* Operates on an Entirely Different, Time Conserving Principle

 Davis & Thompson Roto-Matic Drilling Machines are designed and constructed for high-speed, quality production. Operation is continuous from the minute the machine is put into action until the job has been completely run. No stops or slow-downs are required, even for unloading and reloading. This operation is readily accomplished by the operator as the completed workpieces pass the loading station. Delays so common to conventional indexing-type drilling machines are eliminated entirely on the Roto-Matic. It will set the pace that will enable you to meet and exceed your toughest production schedules.

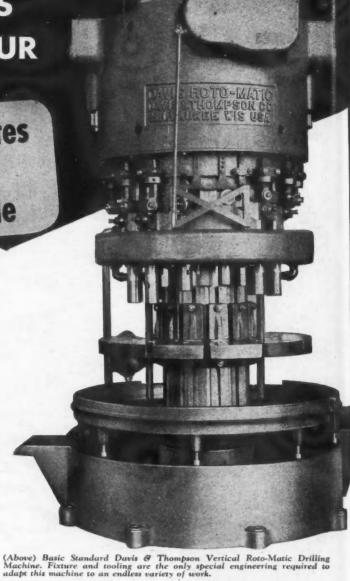
#### The Basis of the "Roto-Matic" Principle"

Continuous operation is the basis of the Roto-Matic Principle. It is a multiple-station non-indexing-type machine. Work and spindles alike, rotate continuously about the drum with the desired operation being performed as they revolve. The average workpiece is readily machined in one revolution. Production is unaffected by unloading and reloading. Thus, on a Roto-Matic Drilling Machine every second of operating time is fully utilized.

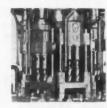
#### Vertical and Horizontal Roto-Matics\*

Both Vertical and Horizontal Roto-Matics are available. They are basically standard machines, designed with sufficient flexibility to permit them to be adapted to various types of work. The Roto-Matic best suited to any particular job will depend upon the size and shape of the work itself, and the operation to be performed. In addition to drilling, these machines can be applied to milling, reaming, counterboring, spotfacing, balancing correction drilling and other similar operations. Consult us and we will be glad to explain how the Roto-Matic can be applied to your particular type of work to increase production. Your inquiry will not obligate you in any way.

\*Copyright 1944 by Davis & Thompson Company.



#### Can Be Furnished With Multiple Spindle Heads



Roto-Matic Drilling Machines can be furnished with multiple spindle heads in each sta-tion. Illustrated here are two typical combinations: a vertical machine



equipped with two spindle heads and one equipped with eight spindle heads. As many as twelve spindle heads can be used, permitting a maximum of 96 operations with every complete revolution about the drum.

Free Booklet-A booklet, containing detailed descriptions of Roto-Matic Drilling Machines is available and will be sent to you upon request without cost or obligation. It will be to your advantage to learn of the many additional advantages that Roto-Matics have to offer. Write today for Bulletin AI-444.





# REPELLENT



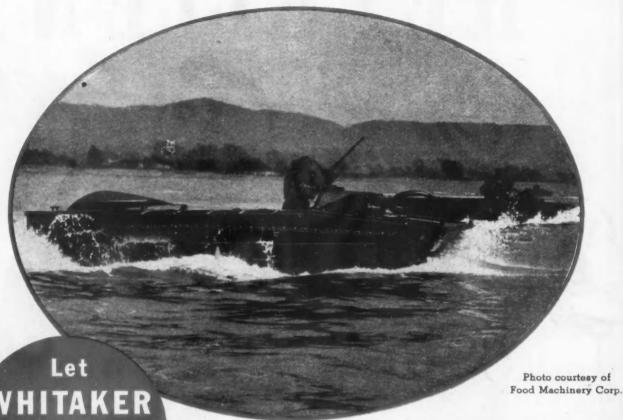
GIVE the interior of your post-war car the final touch of beauty and permanence by using Formica Decorative Sheet. Finished in Formica, door panels and foot guards, cushion rests and the back of front seats become impervious to dirt and grease, scuffing and wear. Functionally, Formica gives your car interior long life, ease of upkeep and lasting sparkle.

But there's more to Formica interior trim than the fact that it's practical. It's modern, warm, colorful and exciting—inviting to Milady -TOPS in SALES APPEAL!

"The Formica Story" is a moving picture in color showing the qualities of Formica, how it is made, how it is used. Available for meetings of executive groups.

THE FORMICA INSULATION COMPANY

# "Water Buffalos" are tough on Tojo!



Let
WHITAKER
help you with
your wiring
problem

WIRING HARNESSES

BONDING JUMPERS

CABLE ASSEMBLIES

AIRCRAFT and RADIO CABLE PRODUCTS

# Whitaker Can Wire It

Through heavy seas and swirling surf, across scorching sands and through dangerous, dense jungles, Uncle Sam's "Water Buffalos" are carrying our fighting men to Victory.

Now that it can be told, we are proud to report that Whitaker supplies the cable assemblies and wiring harnesses for the LVT "Water Buffalos" built for our government by the Food Machinery Corp.

The above is but one of many ways in which Whitaker works with other manufacturers in the production of war needs. Possessing a background of 24 years' experience in the automotive, electrical and radio fields, Whitaker has the "know-how", skilled manpower, and ample plant facilities for a big volume of wartime and post-war production.

We solicit your inquiries. Please mail a wiring diagram or blueprint of the assembly required...Whitaker Battery Supply Company, Kansas City, Mo., St. Joseph, Mo., Philadelphia, Pa., and Oakland, Cal.

# WHITAKER



These instant action clamps are ideally suited for handling removable equipment such as oxygen containers, fire extinguishers, removable duct sections, etc. They combine a snap-on latch with the full adjustment of a standard clamp. They are available in a size and shape to fit any convex surface.

#### CHARACTERISTICS OF MARMAN QUICK-COUPLERS

Circumferential Loading Quickly Installed, Quickly Removed Every Size and Shape



Tension is uniform eround any convex sur-face. No bulging, pinch-ing or distortions.





Quick-Couplers may be opened and wropped crownd and irregular shapes are all the connection without removing the nut.





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RIES

This advertisement is one of a series which is appearing in national magazines and newspapers as Consolidated Vultee's contribution toward a clearer public understanding of transportation's role in the war, and its postwar opportunities and responsibilities.

## 4 days out-4 days back-and the weather be damned!



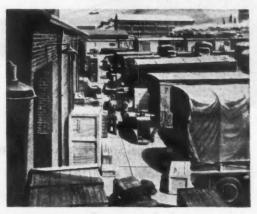
"Tired? I'll say I am! You'd know, if you'd ever flown a 200-mile-per-hour cargo plane in from the Orient for the Air Service Command." He was only 22 years old, this Liberator Express pilot. He'd just brought his ship in — the end of a round-trip run on the longest air-freight haul in the world. From India, 14,000 miles away, to Patterson Field, outside Dayton. Ohio!



Day in, day out, the huge, long-range Liberator Express transports roar down this Ohio runway and streak southward to Brazil's hump, then across to Africa. and on to the very fringe of Jap-held Burma. The boys who fly this shuttle run — in all kinds of weather — call it the 8-day "Pony Express," — 4 days out, 4 days back.



Each Liberator Express carries many tons of highpriority cargo — aircraft parts and supplies urgently needed by American airmen based halfway around the world. Magnetos, fuel pumps, jungle kits, propellers, starters, aircraft engines, radios, and other vital accessories. "It's a rugged run," the pilots say. "But our combat flyers are doing a terrific job out there — and how they need the stuff we take 'em!"



Orametic as the India run is, it's only one of the ways in which we're solving the stupendous problem of supply for United States air bases the world over Every day, thousands of tons of supplies are loaded into freight cars and trucks at huge Air Service Command warehouses scattered over the U.S.A. The furious tempo of Allied aerial warfare calls for miracles of transportation, not only by air, but over highway, by rail, and on the sea.

## CONSOLIDATED VULTEE



Boxes and crates, brought by truck and train, are 5. lowered into the holds of waiting ships. Often, part of the cargo consists of fighter planes which have been flown from factory to dock. Partly dismantled, they are lashed down on girder-like false decks for delivery overseas. Our constant and gigantic torrent of transoceanic shipping is truly a bridge of supply which is taking us closer and closer to Victory.



The plane, the train, the truck, and the ship must team up together to help rebuild the peacetime world, just as they are working together to win the war. In fact, transportation will be a vital key to postwar peace and prosperity.

But the plane will also have a second role to fulfill. For the long reach and overwhelming might of American air power can well become this freedom-loving nation's most effective force for ensuring a lasting peace.

#### Quick Facts for Air-Minded Readers

New role for the "Cer" – Although designed as a Navy patrol bomber, the Consolidated Vultee long-range Catalina flying boat is also being used as a transport, flying natural rubber out of South America.

Now your War Bonds buy more Bombers - In the 1943 fiscal year Consolidated Vultee has made savings of \$251,000,000, which have been passed on to the government in voluntary cash refunds and price reductions and reserves for further refunds. This saving came about through new operating econ-omies and efficient use of manpower, which enabled the com-pany to turn out more planes for less money

North Atlantic Shuttle - It is reported that flights across the North Atlantic, in both directions, are now running more than 1000 a week.

For Distinguished Service — Though operating with only about half their prewar equipment in '43, the airlines of America flew 37,639,000 ton-miles of mail (a gain of 78%) ... 15,774,000 ton-miles of express (a gain of 34%) ... 1,540,000,000 passenger miles (a gain of 10%).

Consolidated Vultee is the largest builder of airplanes in the world.

#### No spot on earth is more than 60 hours' flying time from your local airport

From "Flying Jeeps" to Leviethens of the air — The planes shown below were all designed and developed by Consolidated Vultee. When peace comes, the company will be in a position to provide the postwar equivalent of such planes, from small, privately owned "air flivvers" to huge, transoceanic cargo-and-passenger planes

















AIRCRAFT

Fort Worth, Texas



## JEWELS OF STEEL..PERFECT WITHIN 1/200,000"

One two hundred thousandth of an inch! That's microscopic measurement. But that's how near these lustrous steel balls for frictionless bearings approach absolute roundness.

They are such perfect spheres that the average super-precision gauge can detect no error. They, and the races in which they are assembled, are absolutely uniform in size and hardness.

They're made—millions of them a year—forged, rough and finish ground, hardened, tempered and polished, from Republic Electric Furnace Steel. Because, as one manufacturer put it: "The steel from which these balls are made must be the cleanest, most highly refined metal that can be produced."

Manufacturers of precision products need the added insurance against rejection at final inspection and subsequent loss of material, man-hours and money provided by Republic Electric Furnace Steels. They're as CLEAN and SOUND as the most expert furnace practice and decades of experience can make them.

Republic Electric Furnace Steels are consistently UNIFORM—in physical, chemical, workability, hardenability and performance values. Their homogeneity—their freedom from variables which might upset established fabricating practices—permits manufacturers to derive greatest benefits from mass production methods. They're "targeted" in melting to hit the most rigid specifications—repeatedly.

The unequalled experience acquired by Republic as the leader in this field together with its war-increased capacity are at your disposal to help you produce products that sell—at a profit.

#### REPUBLIC STEEL CORPORATION

Alloy Steel Division
Sales Offices • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO

Berger Manufacturing Division • Culvert Division Niles Steel Products Division • Steel and Tubes Division Union Drawn Steel Division • Truscon Steel Company Export Department: Carysier Building, New York 17, N. Y.



Perhaps you've never been faced by serious fire or flood damage in your plant. But you may be—and it's wise to know where to call for prompt, efficient electrical repair service.

# Fire? Flood? Phone us.

#### FOR ELECTRICAL REPAIRS

Westinghouse District Manufacturing and Repair\*
Plants have had years of experience in handling equipment damaged by fire and flood. Employees with long service records, and thorough knowledge of how to handle and treat such apparatus, are ready to go on the job at once.

In special emergencies M & R Plants draw experienced personnel from other districts or even from Westinghouse headquarters, to help restore apparatus to normal in the shortest possible time.

This is just one phase of Westinghouse M & R service—a nationwide organization of completely equipped repair plants ready to give you prompt, dependable service on any type of electrical equipment.

J-90519



When vital electrical equipment needs repair...phone the nearest office of Westinghouse Electric and Manufacturing Company for



COMPLETE REPAIR SERVICE

33 MAR PLANTS . . ONE NEAR YO

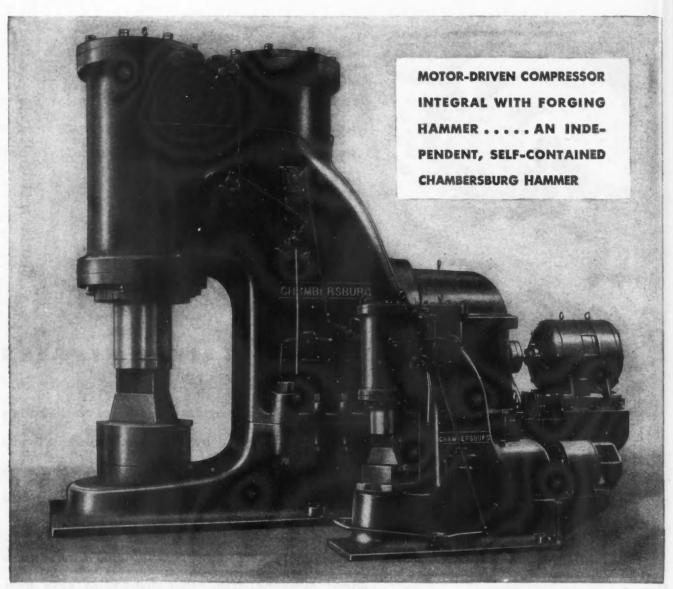
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#### GREATER FORGING OUTPUT

DELIVERING a greater forging output than any other hammer of its type, the Chambersburg Pneumatic Forging Hammer is an ideal tool for industrial shops. The hammer can be located where most convenient, it starts instantly and strikes a constant number of blows heavy or light at the will of the operator. As soon as the motor is up to speed the hammer is ready to operate. "Squeeze" or "hold-down" is provided by a setting of the operating lever latch.

A new bulletin No. 1275 is now ready.

Write for your copy.



CHAMBERSBURG ENGINEERING CO., CHAMBERSBURG, PA.



CHAMBERSBURG

HAMMERS · CECOSTAMPS · PRESSES



Made in accordance with Army and Navy Aeronautical Standards

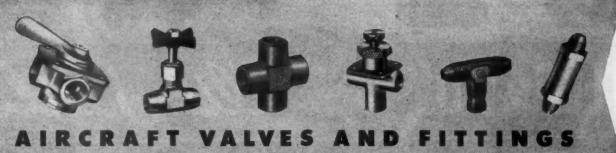
very special equipment to be sure you can get on top-first.

Dole Aircraft Valves and Fittings are precision manufactured and rigidly inspected. Today they are helping U. S. planes fly higher and faster and do a better fighting job.

Tomorrow Dole engineers and production men will offer all this knowledge and experience, plus modern facilities, to help you solve your peace-time problems in aircraft and kindred industries.

THE DOLE VALVE COMPANY

Established 1906
1901-1941 Carroll Avenue, Chicago 12, Illinois
LOS ANGELES DETROIT PHILADELPHIA



Epril 15, 1944

TRIES

When writing to advertisers please mention AUTOMOTIVE and AVIATION INDUSTRIES

129



# The OUNCE of PREVENTION that keeps the VEHICLES of WAR ROLLING

The perfect functioning of war vehicles and implements is dependent upon the ability and efficiency of many component parts—some of them relatively small yet none the less vital to keeping them rolling under the brutal punishment they get.

Bearing protection on mechanized war equipment is one of the most important details of construction, yet the protection preventing dirt, dust, grime, water getting into them, and preventing the life-giving lubricant from seeping out, is accomplished by a relatively small Oil Seal.

Furnishing the tremendous quantities of Milpaco Oil Seals necessary to keep our forces rolling steadily on to victory is our greatest concern at the moment. It must be. Beyond this, we are trying to take care of all of our old customers and will welcome inquiries relative to your oil seal requirements for current as well as postwar applications.

Mechanized Equipment provided with Milpaco Oil Seals for Bearing Protection includes



6317 EAST LAFAYETTE AVE. DETROIT 7. MICHIGAN

PASSENGER CAR
"EASE OF
STEERING"



# WITH Gemmer Steering Gears

Low friction—highest efficiency—smooth, easy transfer of power in the Gemmer Steering Gear, offers passenger car ease of steering for heavy vehicles of all types.

Pioneers of steering excellence in peacetime vehicles, Gemmer has provided similar values for the vehicles of war.

## EFFICIENCY Highest Available.

## STABILITY Firm, positive response.

## SAFETY Abundant factors.

# **DURABILITY**For the life of the vehicle.

#### CONVENIENCE Compact design.

## ADJUSTMENTS - SERVICING Almost Non-existent,

#### GEMMER

#### MANUFACTURING COMPANY

6400 MT. ELLIOT DETROIT 11, MICH.

GEMMER . . . Pioneer of High Efficiency Steering



Aircraft hydraulic systems require almost the ultimate in precision threading for pipe connections. As higher and higher line pressures are used, the more important the joints become. Any slightest play in fittings is multiplied to dangerous proportions by vibration and flexing of lines. Imperfectly mated threads permit a tiny spiral of oil to follow the lead and form leaks. Mechanics trying to stop leaks tighten threads beyond designed limits and spread or swell the boss of the connection and increase the inaccuracy.

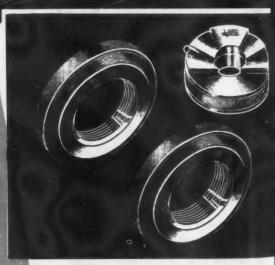
To insure accurate, uniform pipe connections for all aircraft, specification AN-GGG-P-363 was drawn. At least three separate gages for each diameter in male and female thread are required to inspect work to this rigid specification.

VARD makes pipe plug and pipe ring gages to gage threads under specification AN-GGG-P-363; and makes them so exactly that they are used to check connections on hydraulic cylinders subjected to 4000 psi

If you need gages for pipe threads in pitch diameters from 1/16 in. to 6 in. get VARD gages for tested accuracy. Write for complete catalog on VARD gages.



VARD INC.
PASADENA 8, CALIF.





# THE ANSWER TO MANY PROBLEMS



■ Tremendous war-time demands have resulted in the development of scores of new uses for Federal Dial Feed Presses. And every day, these versatile presses are solving more production problems—performing a wider variety of jobs which, until recently, were not thought of as press operations.

Originally employed for secondary operations only, Federal Dial Feeds are now being used for primary and assembly work as well; in some cases, perform intricate combinations of all. Burnishing, broaching, forming, staking, and high speed marking are also handled with ease. The need for highly specialized machinery of limited utility is often eliminated. And production speed is often increased as much as 3 to 6 times.

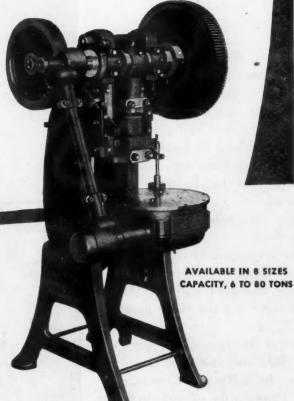
Federal Presses will be equally effective tomorrow, for hundreds of uses in low-cost peace-time production with practically no reconversion costs. Orders are now being accepted for prompt post-war delivery.

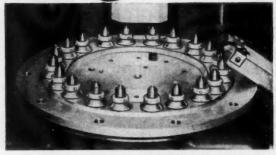


#### WRITE FOR NEW CATALOG

Valuable new catalog illustrates and describes complete line of Federal Dial Feeds and Open-Back Inclinable Presses, Just write—

THE FEDERAL PRESS CO. 504 Division Street, Elkhart, Indiana.





Special application of Federal Dial Feed Press in operation on bullet parts—20 stations, 60 to 80 strokes per minute.



# 70% Cost REDUCTION

THE DAY IS COMING closer when "How much does it cost?" will be a more important question than "When can you deliver?"

The new Acme-Gridley Multiple Spindle Chucking Automatics are built to produce metal parts at lower costs than industry has yet seen.

Take for example the part shown here.

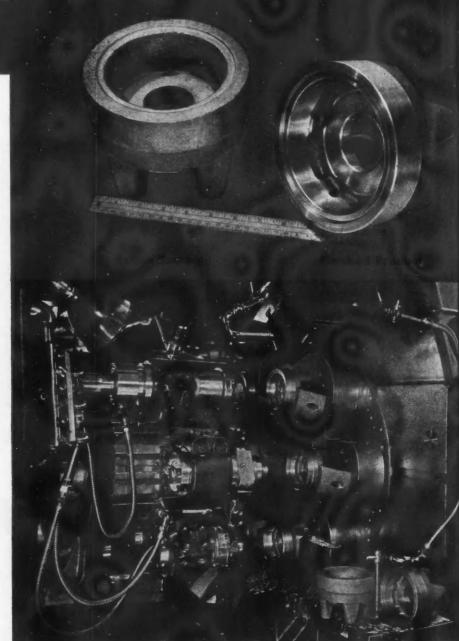
Two Acme-Gridley six spindle chuckers replaced 20 machines in finishing this part and cut the machining costs per piece more than 70%!

Similar savings have been made by Acme-Gridley Automatics—both Bar and Chucking—on thousands of machine operations.

Production costs like these will be the basis for the new low selling prices certain to be necessary in the highly-competitive markets ahead of us.

If you have chucking jobs to do, be sure to read new bulletin CM-43.

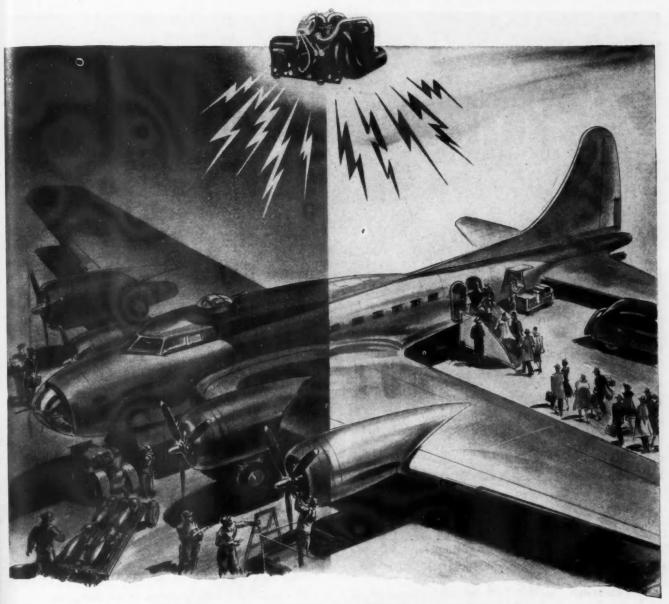
Acme-Gridley Automatics—4, 6 and 8 spindle—Bar and Chucking—give you precision work at speeds and feeds as fast as modern cutting tools can stand.



This 12" RPA six spindle Acme-Gridley Chucker is tooled for 18 separate operations. Job finished in 1/5 the time required by former machining methods—saving equipment, tooling time, power and floor space.

# THE VATIONAL AGMES CO.

ACME-GRIDLEY 4-6 AND 8 SPINDLE BAR AND CHUCKING AUTOMATICS - SINGLE SPINDLE AUTOMATICS - AUTOMATIC THREADING DIES AND TAPS - THE CHRONOLOG - LIMIT AND CONTROL STATION SWITCHES - SOLENOIDS - CENTRIFUGES - CONTRACT MANUFACTURING



### when a 4-ton military load becomes a 4-ton pay load

• When the dark clouds of war ascend and peace is once more restored, many products that were developed to help wrought destruction on the enemy will serve as an important "cog in the wheels" of industry and commerce. One of the most important achievements in the engine field is the Andover Auxiliary Power Unit a gasoline engine whose energy output per

pound of weight is beyond anything imagined a few years ago.

Today this unit is being used in military aircraft to start main engines, hoist bombs, check instruments and battle accessories before take-off, and supply continuous auxiliary electric energy for lighting, heating, radio, interplane communications, etc. Tomorrow, it will carry on its essential work for commercial airplanes increasing the pay-load and furnishing continuous, dependable power on demand.

How portable power can help you in the

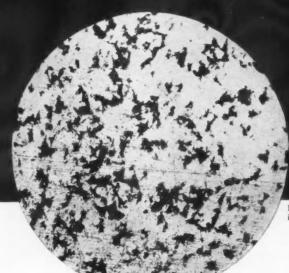
competitive peacetime period can be answered more fully by our engineers, who will be glad to give you complete data. Just write to-

ANDOVER MOTORS CORP.

ELMIRA, NEW YORK WHOLLY-OWNED SUBSIDIARY OF ANDOVER KENT AVIATION CORPORATION

# PORUS - KROME\*

...bristling with tiny pools of oil



Photomicrograph of Ponus-Knome (100X) showing hundreds of tiny pockets in the surface

Thorough "wetting" of the hard chromium in PORUS-KROME is brought about by the tiny pools of oil retained in the pores or pockets in the surface. The 100X photomicrograph shows these pockets in black and the pure chromium, which has been honed, is the light area.

This form of chromium, resistant to both corrosion and abrasion, and so well lubricated, makes PORUS-KROME the best treatment for cylinder

walls and other bearing surfaces. Oil consumption is maintained at a constant low level because PORUS-KROME wears so slowly. It multiplies cylinder life four to twenty times, and reduces scuffing, ring-feathering, and risk of piston seizure.

Let Van der Horst engineers show you how PORUS-KROME can improve the reliability of the engines you are planning for peacetime sales. Write today for information.



PORUS - KROME

Multiplies Engine Life

duces wear, corrosion and scuffing, and greatly multiplies engine life when used on cylinder walls, or other bearing surfaces.

PORUS-KROME is hard chromium, applied by the Van der Horst process that produces pores to hold oil. It re-

VAN DER HORST CORPORATION OF AMERICA

CLEVELAND 11 . OHIO



FROM a mechanical standpoint the decision in World War Number One hinged on the famous French "75".

The secret of this miracle gun was a hydraulic device which absorbed recoil shock and did away with re-rangefinding—thus making possible a new degree of rapid fire.

This device, invented by Maurice Houdaille, a French Engineer, is the *basis* of Houdaille Shock Absorbers.

HOUDAILLE\* hydraulic devices, controlling shocks, rebounds and off-balance forces, have many peacetime and wartime applications: On modern streamline trains, to prevent side-sway and bounce—on all types of automotive equipment—on United Nations' "tank-killers"—as shimmy dampers on nose and tail wheels of our

big bombers, combat and cargo planes—on machine guns to dampen recoil—on the jaws of steam-shovels—on railway switch-points—on heavy drop-hammers—on oil pipe-lines to prevent pressure vibration—just to mention some of Houdaille Shock Absorber adaptations.

Born on the battlefield, Houdaille hydraulic devices have contributed substantially to industrial, transportation, and military progress.

HOUDE ENGINEERING DIVISION

#### HOUDAILLE-HERSHEY CORPORATION

BUFFALO 11, NEW YORK Makers of Hydraulic Controls



\*Pronounced "HOO-DYE"

# Where the "Impossible" In Precision Is Achieved

Here Are FOUR of Many LINCOLN PARK

Firsts

Lincoln Park pioneered the development and is still the largest producer of Carboloy gages.



Lincoln Park was a pioneer in the manufacture and salvaging of gages by chrome plating.

Lincoln Park was the first to produce Carboloy thread gages ... salvage thread gages by chrome plating.



Carblox, recently introduced by Lincoln Park, are the first gage blocks ever produced in comented - carbide

OULD you have believed ten years ago that more than 1,200,000 threaded holes could be gaged with one thread gage? That sort of gage performance is no longer considered unbelievable . . . simply because Lincoln Park tackled the "impossible" job of producing Carboloy thread gages and came up with the right answer . . . and because gages manufactured by Lincoln Park of this wear-resistant material are regularly providing the same long, accurate service life in all types of high production inspection.

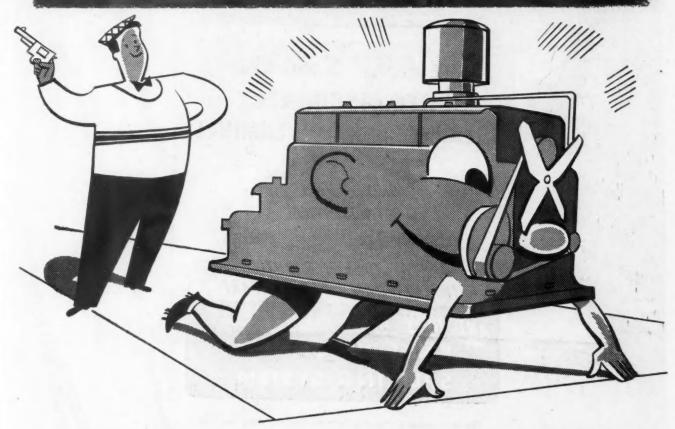
The development of Carboloy thread gages is only one of many new ideas in gage-making which originated at Lincoln Park, Each has contributed materially to modern gaging practice. None would have been possible had it not been for the unusual ability of the Lincoln Park organization to solve the toughest problems in extreme precision work.

There are more new developments in progress at Lincoln Park. You can be sure that some of the most important future advancements in the manufacture of gages and precision tools will come from the plant "where the 'impossible' in precision is achieved."



1727 FERRIS AVENUE LINCOLN PARK 25. MICHIGAN

# Anxious To Go Places!

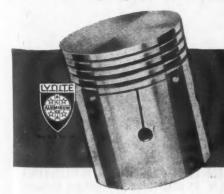


The engine that's powered by Lynite\* LO-EX Pistons is just naturally more on its toes and ready to go. These pistons have low coefficient of expansion, permit close clearances, give maximum heat flow. Oil and gas consumption and carbon formation are held to a minimum. Their lighter weight reduces bearing pressures, so bearings last longer. The result is smooth performance, low cost operation and long life.

Lynite LO-EX Pistons are standard in much of our fighting equipment, just as they were in so many engines before the war. The demands of the military services have, of course, been largely limiting the use of these pistons to essential vehicles. But when more aluminum can be had for civilian purposes, Lynite Pistons will be available on a much broader scale.

When our fighters return to civilian life, they will find these performance-improving pistons ready to give them the same kind of service as they have become accustomed to in everything from jeep to giant tank. Aluminum Company of America, 2110 Gulf Building, Pittsburgh 19, Pennsylvania.

\*Lynite and LO-EX are registered trademarks.



ALCOA ALUMINUM

IES



AIRCRAFT-MARINE PRODUCTS INC. 1521-55 NORTH FOURTH STREET, HARRISBURG, PENNSYLVANIA A&M ACCESSORIES, LTD., 17-19 MELINDA ST., TORONTO, ONTARIO

# DISSTON ne Tool Steels

AVAILABLE NOW!

ELECTRIC FURNACE STEELS OF ORDNANCE QUALITY

• For Aircraft Parts

• For Automatic Rifle Parts, Torpedo Parts, Gun Barrels and 37 A.P. Shot

POSTWAR POSSIBILITIES

Many Postwar possibilities for the use of many posewar possibilities for the use of the tool steels are now apparent. Disston merallurgiers and marinages thoroughly metallurgists and engineers, thoroughly metanurgists and engineers, moroughly experienced in the production of quality alloy and carbon steels by modern electric anoy and caroon seeds by mouera electric for furnace practice, are at your service for advice and comparation in planning for advice and cooperation in planning for the future.

HENRY DISSTON & SONS, INC., 431 Tacony, Philadelphia 35, Pa., U.S.A.

10



## Let a Wet Newspaper Remind You

A NEWSPAPER floats on water until it is saturated —then it becomes heavy and sinks.

Of course, you don't use newspapers in a plane, but many of the materials you do use may absorb petroleum products as readily as a newspaper absorbs water.

So let a wet newspaper remind you that oil seals, hose, packing, gaskets, grommets, diaphragms and all resilient parts used in the presence of oil and gasoline may act just like a newspaper in absorbing weight not included in original design calculations. And the dead weight of thousands of resilient parts in a single plane may seriously handicap its performance.

However, Hycar synthetic rubber with its light weight and its superb resistance to oil to keep it light,

gives protection against excessive dead weight not offered by any other comparable material. Hycar is 15% to 25% lighter than many other synthetics, and retains this important quality throughout its long life. Further, oil-swell can be closely controlled to insure dimensional stability of parts.

Hycar has an operating range of  $-65^{\circ}$  to  $+250^{\circ}$  F. and abrasion resistance 50% better than natural rubber. Unlike many other oil-resistant synthetic rubbers, Hycar has a minimum tendency to cold flow after taking the initial deformation, even at elevated temperatures.

These are qualities you need in resilient materials used in the presence of oil and gasoline. Let our technical service staff help solve your individual problems. Hycar Chemical Company, Akron 8, Obio.



LARGEST PRIVATE PRODUCER OF BUTADIENE TYPE

Synthetic Rubber



# ... but a light frost would ruin the whole crop!"

There's one critical period in the manufacture of huge herringbone gears for U.S. cruisers and destroyers when any marked change in temperature—whether heat wave or light frost—might send them to the scrap pile instead of into the fight.

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You see, it takes many days to cut teeth for one of these big propulsion gears. And work done in the last hour must be as accurate in results as the very first cut. If, somewhere in the process, a temperature change causes uncontrolled expansion or contraction of the metal, it becomes impossible to maintain uniform precision.

In this case, G-E air conditioning and industrial refrigeration team up to keep production humming—regardless of weather. Air conditioning maintains uniform temperature in the cutting room. Industrial refrigeration cools the cutting oil. Together they eliminate the temperature hazards and permit precise matching of gears.

For exacting applications like

these, General Electric has developed efficient and dependable air conditioning and refrigeration equipment that provides accurate control of temperature and humidity. Available for war production uses now... it will be available for all uses after the war.

# T BUY WAR BONDS

General Electric Company, Air Conditioning and Commercial Refrigeration Divisions, Section 444, Bloomfield, New Jersey.

# Air Conditioning by GENERAL BELECTRIC

Hear the General Electric Radio Programs: The "G-E ALL-GIRL ORCHESTRA", Sundays, 10 p.m., EWT, NBC..."THE WORLD TODAY" News, Every Weekday 6:45 p.m. EWT, CBS



Unit Drop Forge Division, Milwaukee, Wisconsin



# "Simplified Printmaking"—explained

A comparison will help do this quickly.

You probably are familiar with blueprinting—with its water and potash baths, driers, plumbing connections, and multiple controls.

In an Ozalid machine all of these are eliminated. Printmaking is simplified. You turn out whiteprints of your engineering drawings, charts, letters in one continuous operation which incorporates EXPOSURE and DRY DEVELOPMENT.

OZALID DRY DEVELOPMENT is the big difference when you compare processes.

It is responsible for the exclusive "printmaking extras" you receive... for compact machine design... and the fact that the operator can be you or anyone.

# Facts About "Simplified Printmaking":

• You can use a complete line of papers, cloths, and foils—an impossibility with "wet" or "semi-dry" methods.

With Ozalid you can produce prints having black, blue, or maroon lines on a white background.

You can make transparent duplicates which may be used . . . in place of valuable originals in subsequent print production . . . or by draftsmen to save time when making design changes.

And you can reclaim soiled or worn originals by making foil duplicates.

- 2. You process all Ozalid materials in the same manner. No solutions to change. No "stops" in production.
- 3. You can use cut sheets as well as roll stock...thus you can eliminate trimming waste by ordering materials the

size of your originals.

# How to Save Time, Labor, and Materials

If you have already installed expensive blueprinting equipment, you can add an Ozalid Dry Developing unit which, when used with your present printer, will give you all of Ozalid's advantages.

If you're being slowed down by inadequate equipment, order an Ozalid Whiteprint machine. There's one for every production requirement. You can rely on it for all your printmaking.

Write for catalog and samples of Ozalid whiteprints today.

# **OZALID PRODUCTS DIVISION**

GENERAL ANILINE & FILM CORPORATION

Johnson City, New York

OZALID IN CANADA-HUGHES OWENS CO., LTD., MONTREAL

# YOU SAVE 4 WAYS...



REYNOLDS SKILLED WORKMEN do your fabricating for you. All that you need to do is furnish blueprints or templates, Reynolds takes care of the rest. Finished formed parts arrive at your plant ready for assembly, saving you valuable time.



IF YOU DO YOUR OWN FABRICATING, big areas like this are taken up by stock, machine, scrap. Take advantage of Reynolds modern, prefabricated plane-parts service and turn over that valuable space to other work.



THOUSANDS OF FREIGHT CARS like this one being unloaded can carry other war materials when plane manufacturers use Reynolds prefabricated plane parts. This Reynolds service does away with needless cross-shipping and handling of scrap.



ELIMINATE THESE HUGE SCRAP ACCUMULATIONS. Aircraft parts fabrication normally generates an average of 30% scrap. The Reynolds Plan keeps this carefully segregated metal at the aluminum source, where it can be put back to work without delay.

# with REYNOLDS Prefabricated Plane Parts

Any production method that can save airplane manpower today certainly deserves serious consideration. Add to this the saving of plant space, transportation and scrap handling and you have a combination that's unequalled in speeding plane production.

Just such a method is Reynolds Prefabricated Plane Parts Service.

- It saves manpower because you receive finished aluminum parts ready for immediate assembly.
- It saves plant space because you do not have to maintain excessive stock piles, do all your own fabricating or store and segregate your own scrap.
- It saves you transportation because it eliminates the need for freight cars to haul scrap metal from your plant.
- And it saves metal because the 30% of every aluminum sheet that normally becomes scrap during fabrication can be put back to work in our plants in a matter of hours instead of months.

#### Reynolds was the first :::

The first aluminum manufacturer to supply finished plane parts from aluminum sheet 3 years ago, Reynolds is, today, supplying finished parts to every leading manufacturer of combat planes.

In that time Reynolds has built up the organization of skilled workers needed to make such a plan smooth-running, accurate, practical This forward thinking and co-operative planning has pushed Reynolds ahead to where its operations now cover 40 plants in 14 states with its own source of Bauxite from which aluminum is made.

This urge to "go places" is what keeps Reynolds men on a continual search for new ways to make aluminum better and easier, cheaper to use.

Take advantage of Reynolds' resources, equipment and engineering skill. For any problem you may have in working with aluminum no matter what it may be, you'll find Reynolds prepared and able to handle it in the most practical way. Reynolds Metals Company, Aluminum Div., Louisville, Ky.

REYNOLDS

**ALUMINUM** 

- and thanks to Ohio Rubben"
uvelue all set on these parits!

Far-sighted companies, now engaged 10% on war production, are planning ahead on normilitary products a minimize change-over delays. The Ohio Rubber Company is co-operating to the point of planning production schedules for prompt action when war time restrictions are modified or removed.

What are YOUR "parts problems" involving rubber or synthetic rubber? Do you seek improved properties of materials to meet more exacting specifications? Is it a seemingly "impossible job" of molding hard or soft rubber or synthetic rubber? Possibly it's an extruded part of unusual characteristics. Or, it may be a combination of problems including adhesion of rubber or synthetic rubber to metal or some other material. Of course, you may be concerned only with lowering costs on present parts which means a more efficient source of supply than your present source. If your problems fit somewhere in that group, try "ORCO-OPERATION."



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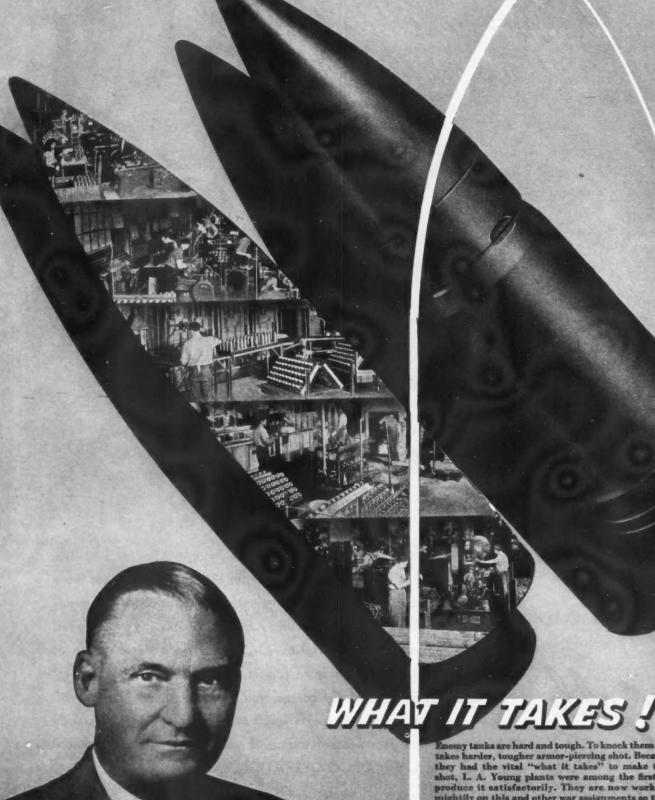
leynolds ost prac-Alumi-

# THE DHIO RUBBER COMPANY . WILLOUGHBY, DHIO

April 15, 1944

When writing to advertisers please mention AUTOMOTIVE and AVIATION INDUSTRIES

14



KNIGHT OF PRODUCTION

Enemy tanks are hard and tough. To knock them out takes harder, tougher armor-piereing shot. Because they had the vital "what it takes" to make this shot, L. A. Young plants were among the first to produce it satisfactorily. They are now working mightily on this and other war assignments so that with Victory they may resume their place as the World's Largest Manufacturer of Springs—to add quality and durability to the products of peace.

L. A. YOUNG SPRING & WIRE CORPORATION . DETROIT 11, MICHIGAN

Branch Plants
CHICAGO: LOS ANGELES, OAKLAND, CALIF.; TRENTON, N. J.; TULSA, OKLA. And In TORONTO And WINDSOR, CANADA





# Now is the time to have SNYDER plan with you for economical production to win customers

SNYDER KNOWS HOW

This machine for reaming leg holes in aircraft crankcase sections, illustrates the adaptability of Snyder standard drilling machines to special machine applications—at a saving of several thousand dollars as compared to the cost of building a special machine for this work.

Two Snyder 10 V 18 standard drilling machine column assemblies are mounted upon a special base. Four fixtures are mounted upon a 60° diameter table with mechanical Geneva index. Spindles on the 9-spindle multiple heads are ballbearing mounted and equipped with oil flingers.

Work-cycle is semi-automatic. First two indexes complete first nine holes. At third station, work is inverted, reloaded and again indexed through both work stations to complete reaming the second nine holes in the housing.

Two factors are of supreme importance in your postwar plans.

First, is being ready ON TIME to get in on the tremendous postwar buying wave. The foresighted are working *now* on designs for production machines to be built as soon as existing restrictions are lifted.

Second, is being ready with a product so thoroughly acceptable in performance and price that it will not only hold original markets but expand and multiply them.

This will require machines which automatically maintain specified tolerances and finishes in one or many automatic-cycle operations, reduce handling and fatigue and automatically maintain a production rate which brings unit costs down to the level of the broadest markets.

With 20 years experience behind it and excellent plant facilities, the Snyder organization is well qualified and fully equipped to design and build the special-purpose machines you will require.

This experience covers special-purpose machines for many types of industry, processing a wide variety of civilian and military products. The knowledge gained in solving these many production problems can be of great practical value to you when applied to your own.

The Snyder Engineering Staff is ready to consult with you now regarding your product, production objectives, cost factors and the coordination of new production units into existing facilities.

We invite you to write us in full confidence. Snyder Tool & Engineering Company, 3400 E. Lafayette Ave., Detroit 7, Michigan.

PLAN Your PRODUCTION
when you
PLAN Your PRODUCT

DESIGNERS AND BUILDERS OF SPECIAL-PURPOSE MACHINES FOR HIGH PRODUCTION AT LOW UNIT COST

20 Years of Successful Co-operation with Leading American Industries

AN

NADA

# VERSATILE...

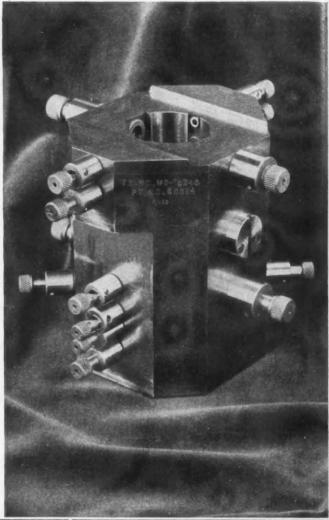
Sometimes a company gets a reputation for producing one particular item better than it can by made by others.

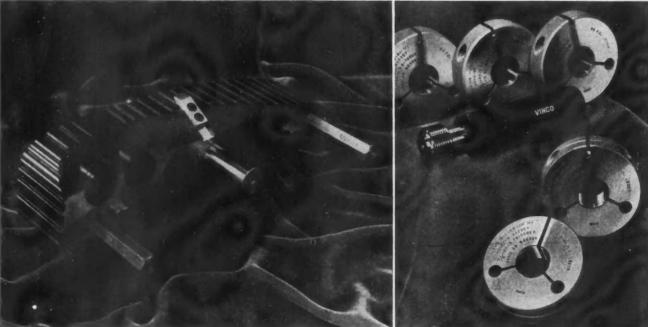
Vinco, pioneering involute splines and their inspection, is known, nationally, for the excellence and accuracy of the involute spline gages made here. Vinco's Involute Checker and Vinco's Dividing Head have been considered "tops" by many key companies using them.

But this is not all that Vinco excels in. Every type of fixed limit gage is made by Vinco with the same unerring skill; fixtures of many kinds and —well, the list is long and is partially shown at the bottom of this page. Look it over and you will probably see items you didn't know were made by Vinco. And remember that 1000 Vinco craftsmen work together to produce Vinco quality.

VINCO CORPORATION 8869 SCHAEFER HIGHWAY • DETROIT 27, MICH.

Sales Offices in NEW YORK and CHICAGO





# MILLIONTHS OF AN INCH FOR SALE BY VINCO

Semi-Automatic Hydraulic Spline and Gear Grinder \* Optical Moster Inspection Dividing Head \* Involute Checker \* Angle Tangent to Radius Dresser \* Index Plates \* Precision Vises \* Sine Bars \* Straight-side Spline, Serration Spline, Involute Spline and Helical Spline Plug and Ring Gages \* Thréad Plugs, Rings and Setting Plug Gages \* Spur and Helical Master Gears \* Munition Gages \* Propeller Hub Gages \* Built-up and Special Gages \* Gear Rolling Fixtures \* Spline and Index Fixtures \* Hydraulic Power, Control, Utilization and Distribution Units \* Engineering, Design and Development.



# . . McAleer can handle the job.

If YOU are faced by the incessant pleas of "Send us more planes, better planes ... sooner!" we'd like to help, wherever and whenever we can.

McAleer's modern Aircraft Division is completely equipped . . . and under the supervision of men specially trained in aircraft plants . . . is ever widening the scope of its production of aircraft parts and sub-assemblies.

The production range of these operations includes—Hydro-press work—Hydrogen, Acetylene and Electric Spot Welding—Routing and Shaping operations and Complete Assembly work including Welding, Riveting and Fabric Covering.

We invite you to take advantage of McAleer's resources, equipment and engineering skill. Use all of your manpower to build planes—use McAleer to replace manpower you cannot afford to spare.

Completely finished parts can go right out on the assembly line as soon as they are received at your plant. You save manpower, plant space and time. Wartime assignments completed swiftly and competently—that's our only job now. How can we serve you?

MCAleer
MANUFACTURING CO.

Manufacturers of Quality-Controlled Finishing Materials, Military Aircraft Sub-assemblies and Pyrotechnics...

ROCHESTER, MICHIGAN

# STANDARD CARBOLOY TOOLS SET THE PACE ON AIRCRAFT PRODUCTION



IN the aircraft industry, on thousands of vital jobs, STANDARD Carboloy tools have set the pace on machining production! Cutting speeds stepped up as high as six times faster than with former tools! Tool life increased often as much as 20 to 1! Finish, on critical parts, so fine that 75% or more of hand-polishing time is eliminated! Close tolerances once believed "impossible" on mass production work, commonly obtained. Production of vital parts often doubled or tripled.

On aircraft manufacture—as well as in all other industries vital to war—STANDARD Carboloy tools have helped point the way towards new economies, new production peaks. These tools—at prices comparable to all other cutting tool materials—are available in 10 styles, 5 grades, for cutting ALL metals and non-metallics. Write for new catalog GT-175, just issued.



11151 E. 8 MILE STREET, DETROIT 32, MICHIGAN

Birmingham - Chicago - Cleveland - Los Angeles - Newark - Philadelphia - Pittsburgh Seattle - Thomaston, Conn.



\* HIGH FINISH! On this steel gear, Carbolay tools produce a finish that eliminates 80% of former hand-polishing needed.



\* EXTRA TOOL LIFE! Machining steel gears for superchargers, Carboloy increases tool life 2800% on eleven operations.



★ INCREASED PRODUCTION! Simply by changing to Carboloy tools, in place of ordinary tools, 86% machining time was saved on this job.



\* EXTRA OPERATIONS ELIMINATED! Tooling with Carboloy Standards made possible the elimination of 4 stations on turret—total of 19 tools saved.

CARBOLOY

For Cutting
CAST IRON
and Non-Ferrous Metals

STEEL

TUNGSTEN CARBIDES \* \* \* TUNGSTEN CARBIDES WITH TANTALUM AND/OR TITANIUM CARBIDES

# IS IT TOMORROW

NOW?

"No, dear, this is today." It's the old story of the boy who could never catch up with tomorrow. Tomorrow will be with us before we know it. Right now we are doing war work exclusively. We are going at the job feverishly-more production today than yesterday...more this year than last. Calmly considered, however, we all know this is not a healthy condition. Some day business must be reorganized to make jobs in a peacetime world.

This company is optimistic of the future. Drop Forgings of Steel will continue to be the most dependable forms in critical places.

But there is another persistent thought: How about the men and women who have left our employ for wartime duties? Surely many of them will want their old jobs back. And

the people who are helping us now. We are thinking of them, too.

To our many customers who laid aside the making of everyday articles in deference to war's demands. we say now that we will want to take up with you where we left off. The tremendous after-war production necessary for rehabilitation and new civilian goods is reassuring when we consider what it can do to re-establish our returning millions of men and women in peaceful pursuits.

> ATLAS DROP FORGE COMPANY LANSING 2, MICHIGAN



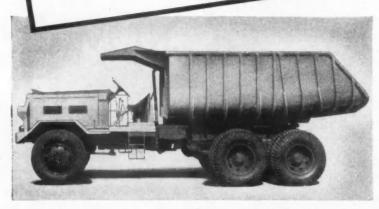
IT IS A DUTY, AN HONOR AND A SAFEGUARD TO BUY U.S. WAR BONDS

DES

RIES

# Throw off the drag of idle weight ...

It has been indicated that this year U.S.S Cor-Ten Steel will again be available in increasing quantities for the construction and repair of buses, trucks, tractors and trailers for approved civilian service.



Cor-Ten gives staming to stand punishing service. "We prefer U·S·S Cor-Ten for heavy-duty truck and trailer frames because of its high yield point and exceptional toughness—the physical properties are not impaired by flame cutting and arc welding."



# build lighter and stronger with COR-TEN

U·S·S Cor-Ten needs no introduction to builders and users of motor transport equipment. In thousands of high efficiency buses, trucks, tractors and trailers — built before Cor-Ten was restricted to purely military application—this pioneer high-strength, low-alloy steel has enabled leading builders of such units to reduce deadweight to a minimum, safely, and at lowest commensurate cost.

Now that COR-TEN again can be used in essential civilian applications—plan to apply it in your equipment to reduce weight that does no work—to increase stamina and endurance—to give you added payload capacity—and to ensure lower operating and maintenance costs.

We will gladly give you all the facts that will assist you in applying Cor-Ten most efficiently. The important thing is that you file your requirements with the proper authorities, now—and send us your inquiries without delay.

Cor-Ten saves 1500 lbs. in framework here. "In these 37-passenger units, the framework constructed of regular carbon steel would weigh 7500 lbs. By using Cor-Ten we are able to reduce this weight 20%, or down to 6000 lbs.—without sacrificing any strength."

Cor-Ten keeps bigger payloads rolling. "In more than 300 Cor-Ten steel bodies now in highly successful operation, Cor-Ten has enabled us to produce equipment that is both lighter and stronger—that operates economically, free from the need of repair far longer than bodies of ordinary construction."





AMERICAN STEEL & WIRE COMPANY, Cleveland, Chicago and New York
CARNEGIE-ILLINOIS STEEL CORPORATION, Pittsburgh and Chicago
COLUMBIA STEEL COMPANY, San Francisco
NATIONAL TUBE COMPANY, Pittsburgh

TENNESSEE COAL, IRON & RAILROAD COMPANY, Birmingham
United States Steel Supply Company, Chicago, Warehouse Distributors
United States Steel Export Company, New York

UNITED STATES STEEL

# PROTECT THE CRANK PIN BEARING, MAIN BEARINGS AND GIBS

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ON YOUR PUNCH PRESSES WITH

# CRECER CENTRO-MATIC LUBRICATING SYSTEMS

Here is a centralized lubricating system that will safeguard the heavy-duty bearings of your punch presses. This modern lubricating system will minimize bearing failure and down-time, and will save the valuable man-hours wasted by the out-of-date method of lubricating the bearings one at a time.

> It is a simple system consisting of a number of Centro-Matic Injectorsone for each heavy-duty bearing and a hand-operated Centro-Matic Lubricant Pump. A few easy strokes of the pump handle and a measured amount of lubricant is injected into the main bearings, the crank nin bearing, and the gibs. Ask the nearest Lincoln Distributor for details, or write us.

### CENTRO-MATIC LUBRICATING SYSTEMS FOR STANDARD PUNCH PRESSES

Available in Complete Kits for Convenience in Ordering and Installing

A Centro-Matic Kit including five injectors, one pump and necessary tubing, brackets, bolts and fittings, ready for installation on a plain, single gib punch press costs \$65.00. Kits for back geared punch presses and multiple gib punch presses are available at proportionately higher prices.

# Easy to Install

Centro-Matic Lubricating Systems are simple to install. Complete instructions come with each kit and any handy maintenance man can quickly make the installation. No special tools or outside assistance is required.

144-5

BUY MORE WAR BONDS



CINCOLN ENGINEERING COMPANY JUNCOLN

Pioneer Builders of Engineered Lubricating Equipment

5701 NATURAL BRIDGE AVE., ST. LOUIS 20, MO., U. S. A.





# Precision

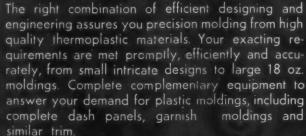
# PLASTIC MOLDING

that meets exacting requirements









Due to the allocation control of plastic materials, our production is at present restricted to direct war and essential civilian work.

Main Office and Plant Este Ave. and Orient St. Cincinnati. Ohio

Branch Plant — Sales Office Richmond, Indiana

> Sales Office Detroit, Mich



The METAL SPECIALTY Co.

MAIN OFFICE AND PLANT . ESTE AVENUE . CINCINNATI, OHIO

PLASTIC DIVISION

# "We at Colonial Value a Pound "We at Colonial Value a Pound Saved on a Plane at \$40000 Says signund Janas, Says signund Janas, PRESIDENT, COLONIAL AIRLINES, INC.



AIRPLANE manufacturers are keeping a constant look-out for practical means of reducing the empty weight of aircraft. One example of this is the uncamouflaged Boeing Flying Fortresses, now being delivered without war paint in accordance with the War Department's recent directive. This change lightens each big bomber by some 60 pounds, adds several miles per-hour speed. All this cannot be measured in terms of money. But on commercial planes, weight saved and increased revenue are synonymous. Here at Colonial Airlines, we estimate that every pound saved is worth \$400.00 throughout the first five years of the life of a plane."

# SEND FOR BOOTS WEIGHT-SAVING BOOKLET TODAY

Comparative weights of various types of self-locking nuts comprehensively reviewed for the convenience of aircraft designers, engineers, operating and maintenance personnel. Copy will be sent you, free, upon request.

### BOOTS NUTS SAVE UP TO 60 LBS. PER PLANE

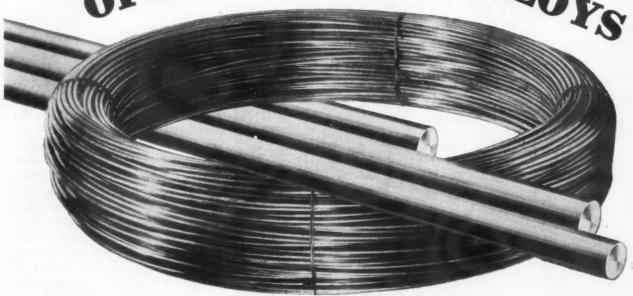
- Much lighter but tougher than other nuts.
- In wartime specified for all types of military aircraft.
- In peacetime will be standard fastenings on commercial planes.
- Can be used over and over without the accelerated locking loss of other nuts.
- "Outlast the plane."
- Approved by all government aviation agencies.

# BOOTS SELF-LOCKING NUTS They Fly With Their Boots On\_Lighter

Poots Aircraft Nut Corporation, General Offices, New Canaan, Conn., Dept. H



# Pittsburgh gives you "Magnaflux Quality" in OPEN HEARTH ALLOYS



Quality alloy steel is simply good sound steel to which regular alloying materials have been added in definite quantities, under rigidly controlled conditions and with adequate skill, to yield specific and uniform analyses and characteristics.

Pittsburgh Steel is past master at the art of making good basic open-hearth steel; and what amounts to decades of added experience, crowded into a few short years by the demands of war, has taught equal facility in the mastery of open-hearth alloy steels.

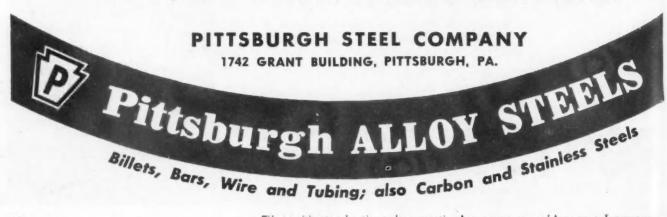
Hence the quality of Pittsburgh Alloy

Steel Bars and Wire of comparable analyses, is surpassed by none . . . a fact readily proved by Magnaflux inspection!

Pittsburgh specializes in light Alloy Bars and all sizes of Alloy Wire in coils or straight lengths, cold drawn from this "Magnaflux quality" open-hearth steel.

New and previously undreamed of uses for open-hearth alloy steels will result from this technological progress in products manufactured from bars, wire and tubing.

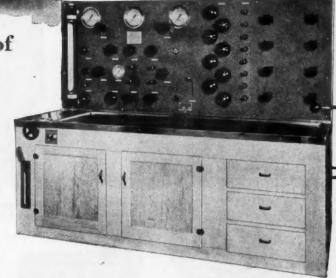
Your inquiries will have the prompt consideration of our technical staff. Write





# Quickly Tests All Types of Hydraulic Equipment for Aircraft

THIS Liberty Test Bench (Type 101) is a high efficiency unit for testing entire hydraulic systems, parts, fittings and accessories. Ideal for testing such hydraulic equipment as Flap Operating and Landing Gear Cylinders, Gun Turret and Gun Firing Mechanisms, Unloader Relief Valves and Flow Divider Valves. Provides a variable flow of oil, up to 12 g.p.m., with pressures up to 1,500 p.s.i. Also provides hydraulic pressure up to 10,000 p.s.i. for burst pressure tests and leakage tests. Complete information will be sent upon written request.



# LIBERTY MOTORS

& ENGINEERING CORPORATION BALTIMORE-1, MARYLAND

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MANUFACTURERS OF AIRCRAFT SERVICE TOOLS AND TEST EQUIPMENT

IES





Derator Simply
Loads and Unloads

Unskilled Help Quickly Trained NCREASED production per worker and the utilization of unskilled help are important advantages of the Thompson Automatic Profile Miller. On the great majority of jobs, the table is in continuous motion and the operator simply loads and unloads the stations at the pace determined by the machine.

Manufacturers of precision parts have increased production rates from 100% to 400% on a wide variety of parts with irregular contours . . . they also do jobs formerly considered "impossible" on a production basis because of their extremely close limits. Substantial savings are also being made on certain plain milling operations that can utilize the advantages of multiple stations, continuous work table movement, elimination of loading time, etc.

Write for new Bulletin 44-A; it illustrates and explains the many other important advantages of the Thompson Automatic Profile Miller.









These precision production parts are representative of the great variety of work done on the Thompson Automatic Profile Miller. If your quantity requirements are not sufficient to purchase a machine . . . or if you first want actual production data on your particular parts, we shall be glad to do the work in our own plant. Quotations entail no obligation. Try us on a really "tough" job.

EARL A. THOMPSON MANUFACTURING COMPANY

# On the Mose/It's Plexiglas

In nose sections on American heavy and medium bombers, PLEXIGLAS gives crystal-clear, unobstructed vision . . . protects the gunner from wind and freezing weather . . . saves precious flying pounds!



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ilnON THE MARTIN B-26

ON THE CONSOLIDATED B-24





ON THE
BOEING
B-17G

ON THE NORTH AMERICAN



PLEXICLAS, developed in Rohm & Haas laboratories, makes possible the familiar plastic "greenhouse" that is the modern bomber's nose—and eyes!

### Clear As Finest Optical Glass

Transparent Plexiclas enables the nose gunner—and gunners in the turret, belly, waist and tail—to aim and fire with deadly accuracy. This transparency is permanent, undimmed by time or extended weathering.

#### Saves Precious Pounds

The strength of Plexiclas is also permanent, providing constant protection from wind, weather and freezing slipstreams. Yet

PLEXIGLAS is only half as heavy as ordinary glass, permitting our bombers to carry bigger bomb loads and longer fuel supplies.

### Technical Service

In addition to these inherent advantages, every piece of PLEXIGLAS also carries with it the cooperation of the Rohm & Haas technical service staff...its physicists determine the best optical contours for sighting...its engineers discuss mechanical details . . . its production men have facilities to fabricate experimental sections.

You are invited to take advantage of this able assistance in your own development work with plastics — present or postwar.

Simply call the nearest Rohm & Haas office — Philadelphia, Los Angeles, Detroit, Chicago, Cleveland, New York. Canadian Distributor: Hobbs-Glass Ltd., Montreal, P.Q.

Only Rohm & Haas makes PLEXIGLAS



3 awards to Rohm & Haas Company and its associated firms, The Resinous Products & Chemical Company and Charles Lennig & Company.

PLEXICLAS is the trade-mark, Reg. U.S. Pat. Off., for the acrylic resin thermoplastic sheets, rods and moiding powder manufactured by Rohm & Haas Company.

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufactures of Chemicals including Plastics . . . Synthetic Insecticides . . . Fungicides . . . Enzymos . . . Chemicals for the Leather, Textile and other Industries





WHEN a large mid-western war plant converted to the manufacture of an important chemical bomb, it looked for a while as if production would be seriously limited. Chief cause of this threatened bottleneck lay in the joining of the cylindrical center section—the operation you see pictured here.

Today, thanks to Mallory skill and experience, the problem is solved and the bottleneck removed. The core of the bomb is quickly joined by Mallory resistance seam welding electrodes. These are made of tough Mallory 3 Metal. Throughout the entire welding operation, wheel and weld are constantly cooled by a running stream of water.

As a result of this combination, three highly desirable objectives have been obtained. Welds are strong

and of excellent quality. Excess warping is avoided, and dimensional stability assured, Finally, the welding wheels go through long production runs before it is necessary to dress the welding face.

Naturally, this is a story the enemy doesn't like. But then, the whole trend of Mallory advancement is running against the Axis tide. In scores of other factories today, Mallory engineering has resulted in longer electrode life . . . welds of higher strength and consistency . . . faster, better wartime production—frequently at lower cost. This same experience is ready to be of service to you—no matter what your welding problem, or to what kind of product it happens to apply. Write today for the comprehensive Mallory Resistance Welding Data Book.

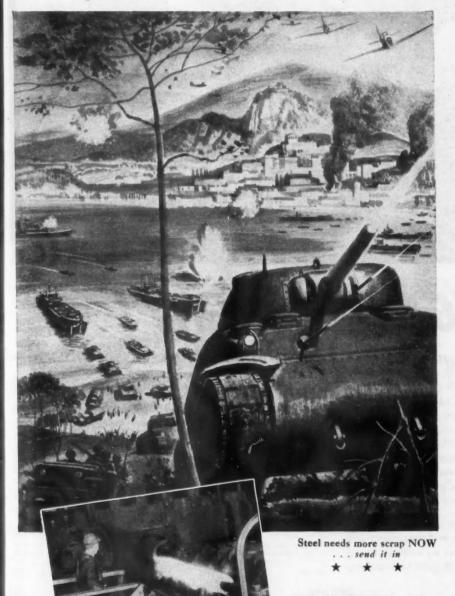
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA



Your Pledge of Faith-Government War Bonds



# JEEPS and TRUCKS TANKS and DUCKS roll on!



Through the shallows, over the sands, into the mountains, the invasion force, fully armored, fully motorized, rolls on to new conquests. Jeeps and peeps, trucks and ducks, tanks and tank busters take their accustomed beating from the terrain and the elements, as well as from enemy fire.

THE ENGINEERS who designed our mobile armor knew what they had to contend with. They made unfailing performance doubly sure by specifying seamless alloy steel tubing for numerous vital applications.

Relatively light in weight, resistant to heat and abrasion, alloy steel parts withstand impact, shock and fatigue, on tanks, trucks and planes. In axles, frames, housings and torque tubes, they are lighter, tougher, stronger than other structural forms.

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For this and many other vital war services, tens of thousands of sleeve bearings, bushings and precision parts in many types and sizes, speed from our six well-equipped plants, 24 hours a day, to equip aircraft engines and landing gear, guns, tanks, torpedoes, submarines, diesel engines.

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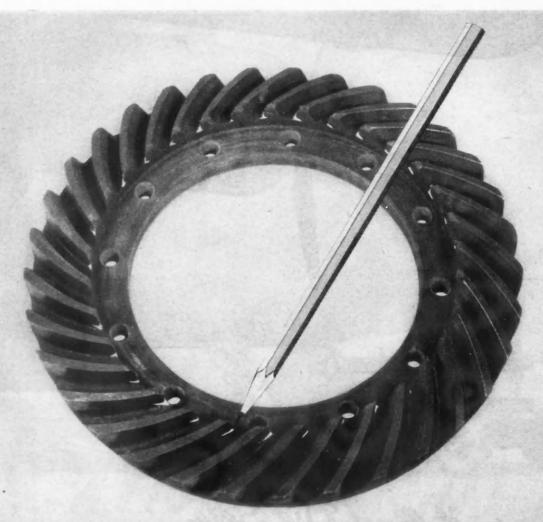
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DeBOTHEZAT LAMINAR FLOW PROFILE FAN with adjustable contravanes shown partially cut away and at minimum setting.

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It would be difficult to find a more gruelling test for motorized equipment than those herculean feats of engineering which have marked the past decade. That the postwar era will bring even greater, more startling achievement in this field is a foregone conclusion . . . but no more obvious than the fact that modern motors and trucks and those many special units which form the backbone of these huge projects will be waiting and ready to assume their normal role in a very abnormal service \*Without exception, in these gargantuan undertakings of man, it's not at all strange that genuine Bendix-Westinghouse Air Brakes and Pneumatic Controls have played an indispensable part by

enabling operators to get the most out of their rolling stock . . . to use its capabilities to the fullest \* This is just one of the countless fields in which the world standard of safety and economy of Bendix-Westinghouse Air Brakes has established itself beyond question. Your local Bendix-Westinghouse Distributor will be happy to tell you, and without obligation, just what specific and exclusive advantages this power-to-stop holds for your particular operation. Check him today. He's a good man to know.

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(Above) Deepfreeze Cascade -120° F. Industrial Chilling Machine

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#### DRILLS



On 21/32" drills used for drilling tank parts, the best possible result before cold treating was 70 holes per grind. Now, after cold treating at -120° F. in a Deepfreeze Cascade Industrial Chilling Machine, the average result of the stock drills is over 700 holes per grind.

On another drilling operation on S.A.E. 4340 steel forgings with a Brinell of 387 to 407, standard stock 11/32" drills have shown an increase of from 48 holes to 256 holes after cold treating for two hours at -120° F, in a Deepfreeze Industrial Machine.

#### TAPS



On a tapping operation, the life of the tap before cold treating averaged about 40 pieces per grind. Now, after subjecting these taps to  $-120^{\circ}$  F. temperatures in a Deepfreeze, production per grind averages 710 pieces.

A screw machine job shop was having trouble on tapping operations on S.A.E. 4340 steel. The taps were constantly breaking and the material tearing. After cold treating both the taps and the unhardened material, the tap breakage was eliminated and better threads were obtained.

#### **BROACHES**



After cold treating high speed burnishing broaches at -120° F. for 3 hours, an increase of from 216 pieces to 648 pieces per grind was obtained.

#### MILLING CUTTERS



On a gang milling operation on a 4340 steel forging with a Brinell of 387 to 402, it was formerly necessary to resharpen the cutters every 7 hours. Now, after cold treating for two hours at -120° F. in Deepfreeze, the average life of these cutters is 24 hours per grind.

On a continuous milling operation a manufacturer formerly obtained 10 to 12 pieces per grind. Now, after chilling in Deepfreeze at -120° F. from 38 to 44 pieces per cutter grind are obtained.

#### SAWS



On a sawing operation on  $5\frac{3}{4}$ " round Mehanite cast bars, a 100% increase in cutter life between sharpenings was obtained after cold treating for two hours at  $-120^{\circ}$  F. in a Deepfreeze Machine.

Another shop was having trouble with Moly High Speed hack saw blades. After chilling at -120° F. for a period of 3 hours in a Deepfreeze Cascade Machine, the life of these blades was increased more than 119%.

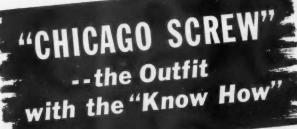
#### FORM TOOLS



On a form cutter used for forming the complete tooth section on a differential side gear machined from a 4820 steel forging, the best performance before cold treating was 150 pieces or 6 hours tool life. Now, after treating for 2 hours at -120° F. in a Deepfreeze, this tool will run 2 days and 2 nights, averaging 510 pieces before resharpening is required.

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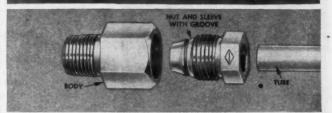
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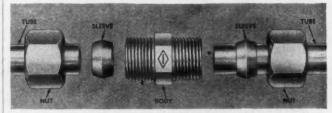
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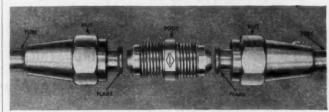
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# **SAE Aeronautical Meeting**

(Continued from page 27)

veloped for 40,000 ft altitude performance. Vanes counter to the fan rotation were considered desirable to increase the pressure boost at high altitude, and these were provided ahead of the fan and made controllable, so that at low altitudes they could be twisted in the direction of fan rotation. This fan runs at crankshaft speed. The pre-twister assembly, including blades visible in the figure, is cast magnesium and the fan blades are micarta, of Keller type design.

Recently a propeller-speed fan and aftervane design embodying the belief that vanes of constant thickness should be equally as effective as streamlined shapes has been designed to improve cruising performance of a large flying boat powered with twin-row radial engines. Fig. 6 is a close-up of this fan, which is currently in production.

### Piston Ring Development for The Ranger V-770 Engine

By C. H. Van Hartsveldt and M. Epps,

Assistants to Chief Engineer, Ranger Aircraft Engines

**D**URING the development of the Ranger SGV-770C engine it was necessary to bring forth a piston ring-

piston combination which would work under the conditions imposed. Because the engine had many features new to American practice at the time, some aspects of the problems were unique. These features are among those listed here: Engine Type—in-line, aircooled, inverted-V; Horsepower—take-off 520 at 3150 rpm, normal 450 at 3000 rpm; Displacement—770 cu in.; Bore—4 in.; Stroke—5½ in.; Average Piston Speed—at take-off, 2690 fpm; BMEP—at take-off, 170.

After the initial tests the effect of clearance was investigated and it was apparent that the minimum possible piston clearance, as dictated by top land heavy bearing and piston seizure, was desirable. This was concluded from results showing less oil consumption and blow-by with lower piston clearances. In testing, clearances of .020 in. and .016 in. at the top and bottom of the skirt respectively caused piston seizure during running at takeoff power, and the final choice for skirt clearances of .002 in. at the top and .018 in. at the bottom were chosen. With these clearances no further tendency for seizure was noted.

The full scale endurance testing culminated in Army-Navy Model tests for the piston fitted with 1/16 in. plain compression rings and also for the

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same combination fitted with a porous chrome plated top ring. The cylinder wear in the first case was a maximum of .006 in. and the chrome-plated ring reduced this to .001 in. Average ring gap increase was .004 and this did not change appreciably when the chromeplated top ring was used.

When engines are manufactured in quantity each of the variables swings through the production tolerance allowed, and certain combinations of circumstances occur which tend to scuff and feather piston rings. Because of this the problem can not be fully anticipated with the limited number of engines selected for development testing. As a result it may be necessary to make changes in piston rings after engine production has started.

#### The Design For Production of **Sheet Metal Aircraft Parts**

By Frank M. Mallett

Production Design Engineer, Curtiss-Wright Corp.

As ILLUSTRATIONS of the work of the Production Design Engineering Department, whose function is to so control the design of the product that the manufacture can be facilitated, the speaker presented rational approaches to the design of curved flanges, beads, flanged holes and joggles in sheet metal parts. The analyses presented were all directed toward answering the question "How much elongation or compression does a given design call for, or, given upper limits of elongation and compression for various conditions, how are we to design within these limits?" The following analysis of stiffening bead design is typical:

Fig. 7 shows a section through a bead made by a plane perpendicular to the lengthwise axis, and Fig. 8 shows a section through one end of the bead by a plane through the lengthwise axis.

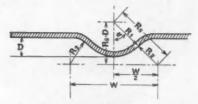


Fig. 7 Section through stiffening bead by plane perpendicular to the lengthwise axis

If E represents unit strain, L the curved length of the cross-section in Fig. 7, and W the flat width of the bead as indicated in the figure, then

$$E = \frac{L - W}{W},$$

and, from the geometry of Fig. 7,

$$E = \frac{R_s \arccos \frac{R_s - D}{R_s}}{\sqrt{2R_s D} - D^2} - 1,$$

where  $R_s = R_1 + R_2$ , and D = the

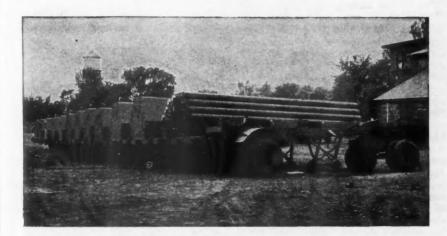
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bead depth, as shown. This expresses unit strain as a function of two of the essential variables. Introducing the parameter x, where  $R_s = xD$ , the following

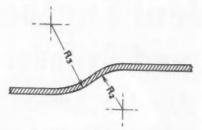


Fig. 8 Section through end of stiffening bead by plane through the lengthwise axis

lowing expression for unit strain as a function of this parameter alone is

$$E = \frac{x \operatorname{arc} \cos \left(1 - \frac{1}{x}\right)}{\sqrt{2x} - 1} - 1.$$

If E is to be limited to the desirable value of 11 per cent, the following proportions should be maintained:

$$x = \frac{R_s}{D} = 3.5.$$

A good standard shape consistent with this is obtained by maintaining

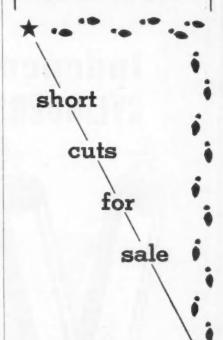
$$R_1 = 2D$$
,  $R_2 = 1.5D$ , and  $R_3 = 12D$ .

#### **Fundamentals of Airplane Design**

By A. L. Klein, Design Consultant, Douglas Aircraft Co.

THE three underlying fundamentals of aircraft engineering that must influence every design decision are: safety, weight, and serviceability. The airplane industry's wide use of cable controls in place of push rods and torque tubes is an example of the necessity of advoiding mechanical parts that can fail suddenly and without warning. Steel cable is an ideal type of aircraft device. It is a multiple structure, it has internal damping, and long before it fails completely, it gives an easily indication of potential detectable danger. Furthermore, cables seldom jam and, therefore, permit the operation of the mechanism by an alternate or auxiliary means. Landing gears also need auxiliary lowering means, brakes need stand-by power, and every engine has two magnetos. However, this principle of duplication must not allow the designer to relax his effort to increase, by improved design, the reliability index of the primary means

Weight: There is a tendency on the part of many engineers new to the industry to believe that small items are unimportant and that weight saving is POST WAR STRATEGY



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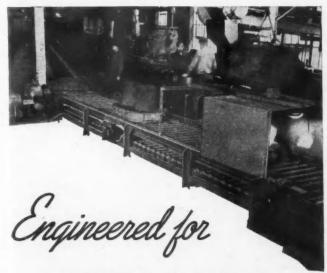


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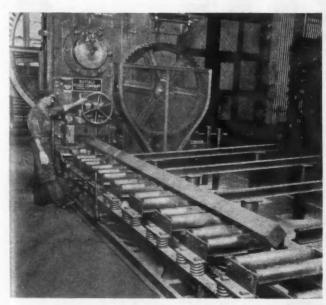
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necessary only on the larger ones. In order to indicate the relative importance of the parts commonly thought important, a rough weight breakdown of the C-54A is given in the following table:

#### Distribution of Weight Empty of C-54A Transport

From this table it is easy to see that "the primary structure is of secondary importance." The design of accessory and equipment items furnishes a ready field for weight savings that collectively might be worth far more than the entire cost of the equipment.

The increase in electrical generator output from 600 watts to 7200 watts, with only a 40 per cent increase in weight, may be taken as an example of the latent improvements possible in many fields. Another example is the development of the new type aircraft electrical conductor. This new wire is not only lighter (60 lb saved per airplane on the C-54) but is also fire resistant and superior to all other conductors in high and low temperature bending and abrasion resistance.

Serviceability and Manufacturabil-

ity: Interchangeability of components is not only of great interest to the users but compulsory for the manufacturer. As is becoming well known, assembly and installation operations constitute 80 per cent of the man-hours in the manufacture of aircraft. That the fabrication of the sheet metal parts of an airplane is an important part of its manufacture is far from the case.

The principal problems in aircraft manufacture are two in number. The first, and by far the most difficult, is to schedule and keep track of the great number of parts involved. The second problem is to have parts that fit after they are manufactured. There are three types of error associated with manufacturing operations which cause changes in dimensions during manufacture and thus will cause parts to be in error even though the tools are perfect. Thermal effects produce one of these difficulties. Another source of errors in parts is the changes in dimensions caused by the various manufacturing processes. Heat-treated aluminum alloys, in common with other materials, have internal strains introduced by heat treatment, so when such a part is machined, it will warp in such a manner as to give up some of the potential energy stored by the heattreatment process. Riveting expands both the riveted parts and the rivets. In general, welding operations cause components to shrink.

There also is another major difficulty due to the very nature of aircraft. In the DC-3, for instance, the wing tips are 20 in. higher in relation to the body when in the air than they are on the ground. More modern airplanes have larger deflections due to the development of structures of greater efficiency designed to smaller load factors. Because of this flexibility, fuselage frequently sag as much as 11/2 in. on being removed from their jigs. Other parts deflect noticeable and troublesome amounts on being removed from their supports. The above effects result in no airplane doors being interchangeable. After a number of airplanes have been made, the doors can be made a shape that approximates the shape of the fuselage and then be handworked a small amount to make them fit their individual fuselages. The problem of making truly interchangeable doors will probably never be solved unless large weight sacrifices become possible.

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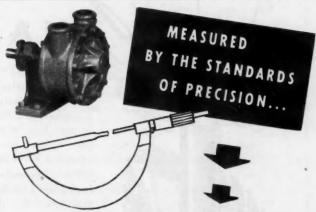
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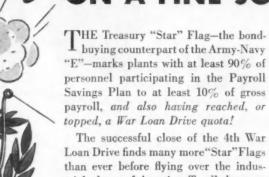
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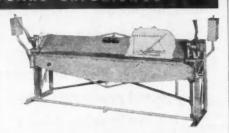
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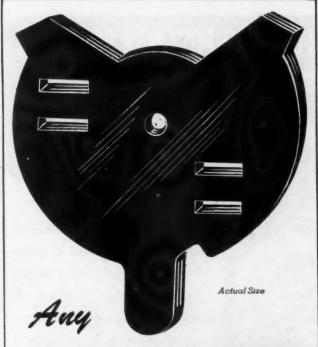
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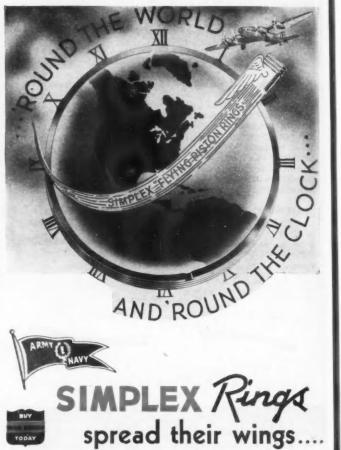
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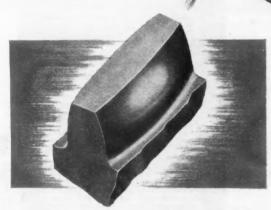
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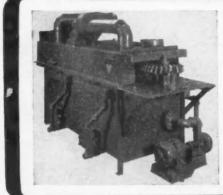
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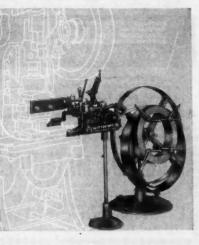
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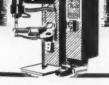
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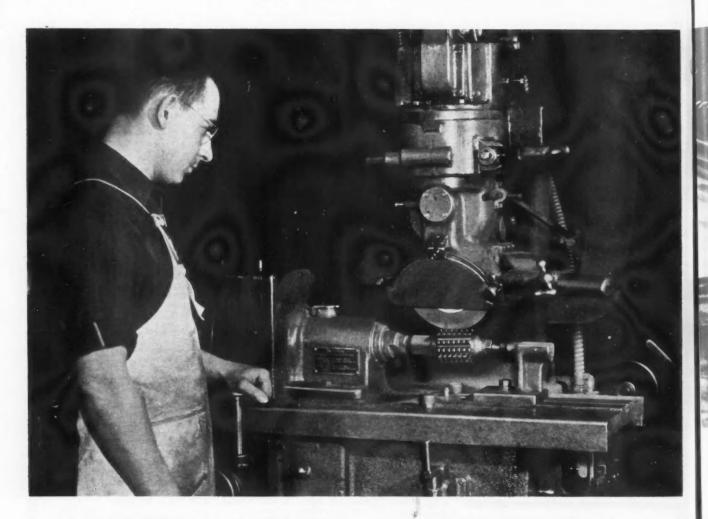
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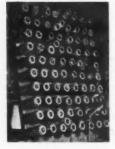


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